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QUESTIONS ARISING IN THE CONSIDERATION OF THE FINANCIAL AND BUSINESS ASPECTS OF MUNICIPAL . ELECTRICITY SUPPLY. .

621.3
C38q

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Electricity supply being a public utility service upon which, due to its extremely rapid expansion, the general welfare of a large section of industry and the comfort and convenience of an increasing number of households now largely depend, there is need for a clearer understanding of the fundamental principles underlying its commercial operations. A very careful analysis of facts is necessary to obtain a true appreciation of the results achieved, and in view of the controlling influence exercised by the financial and business aspects of the Industry it is important that misconceptions (which, alas! are only too easily formed by a superficial examination) should be avoided.

The principal problems that arise fall within one or other of the following main heads:—

(1) Capital required, how it has to be expended, the means adopted to raise money, and methods of repayment of loans, etc.

(2) Costs of Production, how they arise, and their allocation.

(3) Charges for supply to different classes of consumers.

(4) Application of Revenue earned.

(5) Records; of both Capital and Revenue, and the Statutory Form of Accounts.

(6) Distribution of Supply.

(7) Sales and Commercial Development.

(8) Legislation governing the Industry.

The writer deals with these items in a general review, having regard to the above points, present day requirements, and the desirability of standardisation in the treatment of many questions of general application throughout municipal undertakings.

SECTION I.—Capital required, how it has to be expended, the means adopted to raise money, and methods of repayment of loans, etc.

Capital Required.

A relatively large capital investment is necessary in electricity supply, or, in other words, the turnover (the ratio of the total revenue per annum to the capital employed) is small. This feature accounts for many of the difficulties encountered, and the question is one of prime importance at present.

In the early days of the Industry the capital charges, that is, interest on moneys borrowed and provision for redemption of loans, were of such magnitude per unit sold as to exercise an almost unchecked influence on expansion. This was due to the low cost of fuel and labour in those days and to the small use made of the plant installed. The proportion of these charges to the total expenditure has been gradually decreasing owing to rises in the price of coal, to higher load factors, to the reduction in expenditure per kilowatt installed on account of manufacturing development and the possibility of using larger sets, and to the increased diversity factors obtained with a mixed supply of lighting, power, heating, cooking, etc., until within recent times the capital charges had sunk to probably a lower percentage of the total costs than previously known.

Two factors in connection with capital now confront the Industry, however; firstly, the large increase in the cost of buildings, plant, mains, etc., and secondly, the high rate of interest on loans.

Capital charges forming a good percentage of the cost of producing and supplying electrical energy, the operation of plant installed at pre-war prices has made it possible to maintain supply in many cases at charges that are a lower increase upon pre-war rates than those of almost any other commodity, but when new plant and mains have to be purchased and any extensions of magnitude are contemplated, these two factors will have a pronounced influence and tend to reinstate the capital charges in their old predominating position in the cost sheet.

The effect of present conditions is illustrated by the following figures :—

Item.	Cost :		
	Pre-war.	Present.	Increase.
Capital Expenditure ...	£100 0 0	£250 0 0	150%
Revenue Charges : —			
Interest	£3 10 0	£16 5 0	364%
Repayments	£3 14 0	£8 16 0	138%
Total	£7 4 0	£25 1 0	248%

In addition to an increased outlay, the rates of interest on borrowed moneys have advanced ; thus while the capital expenditure as shown above amounts to two and a half times the pre-war figures (150% increase), the total charge to revenue, including interest and repayments, is almost three and a half times as much as it was (nearly 250% increase).

Present conditions will inevitably arrest development, and hinder the progress of economical fuel utilisation, with consequent national losses. It is imperative that efforts should be made to relieve the situation without any avoidable delay by either bringing down the price of plant, mains, etc., or devising a system of financing the industry so as to reduce the capital charges. Either alternative offers a promising field for cultivation, and it would be an interesting exercise to determine at what point and to what extent it would pay electrical manufacturers to reduce their margin over cost for plant, mains, etc., required by supply undertakings in view of the greater demand for consuming devices that would follow a sensible reduction in charges for supply.

Interest is a serious item where moneys have to be borrowed for capital purposes; the weight of this charge is apparent from the above figures and from Diagram No. 1. The effect of a high rate of interest is keenly felt at the present time with enhanced prices, especially when loans are raised by means of stock having a long term of repayment. The result is extreme difficulty in embarking upon new schemes urgently required, and it seems worth considering whether any help could be obtained by devising a system of loans with variable interest, the rate being fixed on a base with increases or decreases similar to those operating in connection with other charges.

How Capital is Expended.

An examination of the published capital accounts of several undertakings will reveal striking differences in the relation of the amounts invested in the various sections of the business. This is due to local conditions, the degree of development of the supply area, etc., but beyond these factors it is apparent that no definite standard has been generally adopted in allocating expenditure to the account headings, with the result that it is impossible, unless after a long and detailed enquiry, to obtain a reliable set of figures for the purpose of presenting a clear view of the position. Generalising, however, it is fairly accurate to say that about one half of the capital employed has been spent on generation, the other half being claimed by distribution. This fact has a noteworthy effect on the general development of supply, especially in some areas.

Different powers are held and different methods adopted all over the country in the management of capital moneys, but during the past twenty years or so several questions of importance have arisen and brought about inquiries as to the best means to be adopted to secure the reduction of expense in this connection as much as possible and so far as may be done without injuring financial stability.

Means Adopted to Raise Money.

The modern means of raising loans are:—

(1) Redeemable Stock.

(2) Mortgages:

  (a) Borrowed for the period required;
  (b) "Short term," usually subject to six months' notice of repayment from either side.

(3) Utilisation of Redemption and Sinking Funds.

Redeemable stock with a long term of repayment is valuable when it can be issued in a cheap market, as owing to the fact that the period of repayment has no necessary relation to the period of redemption of loans sanctioned for any particular application, the money can usually be used over and over again, and without additional expense. Further, owing to the state of the money market, it is sometimes possible to purchase stock out of redemption fund moneys at a considerable discount.

Moneys borrowed on mortage for the period required (that is, to be repaid to the lenders at the end of the prescribed term of redemption) do not require comment. "Short term" mortgages, however, should be more fully noted, as the rate of interest on these borrowings is usually higher, due to the insecurity of the lender, whose money may at any time, after short notice, be repaid to him, when he has the trouble of finding other investments. This feature acts against the authority also, and may prove temporarily inconvenient. Further, the individual sums realised in this way are as a rule small and the number of mortgages large, entailing additional work and expense to the authority. On the other hand, this type of mortgage is the only one with which the benefits arising from the use of sinking funds in the earlier repayment of loans can be obtained.

Repayment of Loans.

The usual desire of authorities seems to be to obtain the longest possible repayment period for loans, and although in many cases where electricity supply undertakings are concerned it is essential to extend the term of borrowing, or relieve the first few years of repayment provisions, to enable pioneering work to be carried out, the matter needs careful deliberation. It is impossible immediately to secure full load for plant and mains as these are installed, expenditure being necessary in large blocks as the existing load overtakes the station or distribution network capacity. Thus heavy outlay is frequently required ahead of demand, under which circumstances the effect of an unduly short loan period, or immediate and uniform redemption measures, is particularly distressing. At the same time, sound finance requires that loans should be liquidated within the economic life of the asset, and it should be remembered that the expenses incurred on interest are often much the heavier portion of capital charges. The total charges on account of a loan increase with extension of the repayment period, and although of course the annual charges decrease, the reduction in these is small after a certain point. Diagram No. 1 makes the position clear in cases where a sinking fund is employed.

All capital expenditure is in reality deferred revenue expenditure because revenue must provide the moneys necessary to renew the assets or repay the outstanding debt, if a loss is to be avoided. It will be found much cheaper to buy assets direct out of revenue than to borrow for the purpose, and although it is not feasible to provide very large amounts out of any one year's revenue, particular attention is directed to the desirability of buying all small items such as meters, services, tools, and instruments, either out of the reserve fund where this exists, or out of current revenue.

Loan redemption systems are divided into two main classes:

(4) Where the principal sum is repaid in part in each period (of say a year);

(5) Where the principal sum is repaid in whole at the end of the term of borrowing.

These classes are covered by:—

(4) (a) The Instalment System;
    (b) The Terminable Annuity;

(5) (a) The Non-Accumulating Sinking Fund;
    (b) The Accumulating Sinking Fund;

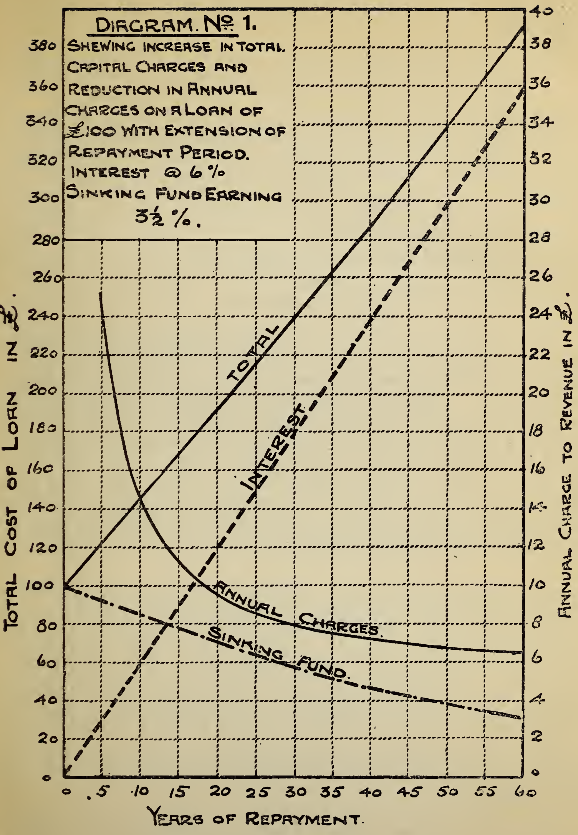


DIAGRAM. No. 1.
SHEWING INCREASE IN TOTAL CAPITAL CHARGES AND REDUCTION IN ANNUAL CHARGES ON A LOAN OF £100 WITH EXTENSION OF REPAYMENT PERIOD.
INTEREST @ 6%
SINKING FUND EARNING 3½ %.
TOTAL
INTEREST
ANNUAL CHARGES.
SINKING FUND.
TOTAL COST OF LOAN IN £.
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
ANNUAL CHARGE TO REVENUE IN £.
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
35
40
45
50
55
60
YEARS OF REPAYMENT.

and they may be re-arranged into two further main groups according to the mathematical problems that arise in connection therewith :—

(6) Where simple interest only is in question, and ordinary arithmetical calculations will enable one to carry out the method and ascertain the correct charges and apportionment;

(7) Where compound interest is involved and aid must be sought of the mathematical principles dealing with geometrical progressions to carry out the method and ascertain the correct charges and apportionment.

These groups comprise :—

(6) (a) The Instalment System;
  (b) The Non-Accumulating Sinking Fund.

(7) (a) The Terminable Annuity;
  (b) The Accumulating Sinking Fund.

The instalment and non-accumulating sinking fund systems are the simplest to work and prima facie the cheapest to adopt, but the limitations imposed render them unsuitable for general application. The main objections are, that the annual charge against revenue is not uniform but may vary by nearly 50% between the latter and earlier terms in the repayment period; that the heaviest charges fall in the first few years, when the revenue account can least afford to bear them; and that the systems are not flexible. It is sometimes argued that the unequal charge to revenue is set off by the costs of repairs varying in the opposite direction, but this is not always true.

The terminable annuity system is based upon the total return that can be obtained from the investment of a certain amount of money for a certain period at a stated rate of compound interest, this return being divided over the number of years and repaid in equal instalments, allowance being taken for re-investment at compound interest at the same rate. This method, while providing for the repayment of part of the principal yearly (a strong objection to most lenders), is a distinct improvement on the instalment system in that the charges are distributed equally with accuracy over each year of the loan period.

The accumulating sinking fund is a system under which interest is paid on the full amount of the principal sum throughout the period of borrowing, and annually such amounts set aside as will, with accumulations at compound interest throughout the period, realise a sufficient sum to repay the principal at the end of the period. This is at once the most complicated, most flexible, and most generally adopted system.

There is a close relationship between the terminable annuity and the accumulating sinking fund, and provided the rate of interest on which the payments to the sinking fund are based is the same as that paid in respect of the loan, the total capital charge would theoretically be the same under either system. Under present conditions, however, the result would be rather different, owing to the high rate of interest required and the fact that sinking fund contributions cannot be based upon too high a nett return. The difference is in favour of the terminable annuity, which to-day will be found the cheaper system.

Sinking Fund Applications.

Sinking fund moneys must be applied in one of three ways :—

(8) In accumulating to maturity by investment;

(9) In earlier repayment of debt;

(10) In the exercise of new borrowing powers.

The disadvantages attaching to No. 8 are the cost of investing and the possible loss by fluctuation of the market price of the securities.

General powers exist enabling local authorities to use sinking fund moneys in earlier repayment of debt provided consequent losses of interest are paid into the fund, and this is an important advantage as if the payments to the sinking fund are based on a lower rate of interest than is paid on the loan, savings may be effected by so applying the moneys as often as possible. This application further saves the cost of investing.

The utilisation of sinking funds for capital purposes has been the subject of much discussion and controversy. Before the question is dealt with it is necessary to explain the terms "Loans Funds," "Redemption Funds," and "Sinking Funds," as a lack of understanding of the statutory meaning of these may create some confusion. Generally, it may be said that " Loans Fund " and " Redemption Fund " are the names given to funds established for the repayment of stock, " Sinking Fund" being the term applied to a fund set aside for the redemption of loans raised by other means. The distinction is one without much difference (it would have been clearer if the term " Sinking Fund " had been used in all cases with a prefix to signify the form of debt to which it applied), but has to be borne in mind, as although the principle of using moneys accumulated for the repayment of debt for further borrowings granted has legal sanction in a number of Local Acts and the Ministry of Health Stock Regulations, these powers only extend to moneys relating to stock. Few local authorities have power to use moneys relating to other forms of debt in this way, though they may be obtained. It is distinctly desirable to be able to use sinking funds for capital expenditure, and such a power would be beneficial for the following reasons :—

(11) It would restrict the total outstanding external debt;

(12) It would overcome the necessity of constantly placing new loans on the market;

(13) It would save the difference between issue at par and the price realised on any loans offered, and the cost of raising fresh loans;

(14) It would save the cost of investing the fund;

(15) It would guard against depreciation of, and consequent losses on, any such investments;

(16) It would save the present interchange of securities between local authorities.

The total savings, especially at times like the present, might be considerable.

Calculations.

Although all information as to sinking fund contributions and annuities may be obtained from actuarial tables, the principles underlying these systems cannot be appreciated by the use of such, and it may be of interest to give the following :—

$$S = AR^n$$

where S is the final sum accumulated, A the present amount, R £1 increased by the rate per cent. for one year, and n the number of years.

This formula relates to a steady accumulation of a certain sum of money at a stated rate of compound interest.

The matter is more complex when one comes to deal with the accumulation of periodical contributions. Then the problem is not purely a geometrical progression, but a series of such. It has been deduced that—

$$C^n = S\left(\frac{r}{R^n - 1}\right)$$

where Cn is the periodical contribution, S the final sum accumulated, R £1 increased by the rate per cent. for one year, and r the amount of interest on £1 for one year.

The method of finding the annuity value of a given amount is to determine the present value of an annuity of £1 for the period at the rate per cent. required, and divide this into the amount. The present value of an annuity is the same as the present value of the sum to which the annuity would accrue during its life at the rate of interest specified. Proceeding on these lines, as the ultimate sum is—

$$S = C^n\left(\frac{R^n - 1}{r}\right)$$

this figure may be obtained for a £1 annuity and the present value then determined as

$$A = \frac{S}{R^n}$$

and the result divided into the amount to be invested, giving the annuity. Reducing the whole argument down, it resolves itself into the formula—

$$Ay = A\left(\frac{R^n r}{R^n - 1}\right)$$

The writer has prepared a table (given below) showing the amounts required to be set aside annually over different periods of years at different rates per cent. of compound interest to provide an accumulating sinking fund for the repayment of £100, which table, it is hoped, will be useful in connection with estimates involving the inclusion of capital charges. The method of using the table is to select the number of years repayment and the rate per cent. on which the sinking fund is based, and multiply the figure by the times £100 divides into the sum proposed to be spent. The table includes only sinking fund contributions, and not interest, because in most cases the rate of interest payable on the loan and the rate of accumulation of the fund are different. The amount of interest on the loan has to be added to the repayment contributions ascertained. In the case of a terminable annuity, the rate of accumulation on which the sinking fund is based would be the same as the rate of interest on the loan.

Table showing the Annual Contributions required to an Accumulating Sinking Fund to produce £100 in the number of years stated at different Rates of Interest

No. of Years of Repayment of Loan.	Rate of Accumulation of Fund.				
	3%	3½%	4%	4½%	5%
60	.6133	.5089	.4202	.3454	.2828
50	.8865	.7634	.6550	.5602	.4777
40	1.3262	1.1827	1.0523	.9343	.8278
30	2.1019	1.9371	1.7830	1.6392	1.5051
25	2.7428	2.5674	2.4012	2.2439	2.0952
20	3.7216	3.5361	3.3582	3.1876	3.0243
15	5.3766	5.1825	4.9941	4.8114	4.6342
10	8.7231	8.5241	8.3291	8.1379	7.9504
7	13.0506	12.8544	12.6610	12.4701	12.2820

SECTIONS 2 and 3.—Costs of Production, how they arise, and their allocation. Charges for supply to different classes of consumers.

These two questions are so intimately connected with each other that they are taken together.

The large percentage of revenue claimed by capital charges has already been referred to, and these, together with fuel, completely overshadow in importance all other items in the cost of production. The following figures illustrate the composition of the total costs of electricity supply, and, being fairly representative, are a reliable guide to the questions worth pursuing in any efforts to economy.

1 Year.	2 Capital Charges.	3 Fuel.	4 Sub-Total of Nos. 2 and 3.	5 Repairs and Maintenance, Water, Stores, etc.	6 Shift and Running Wages.	7 Local Rates. all Management Expenses and Salaries.	8 Total.
	Percentage to Total Costs.						
1911-12	42	21	63	17	6	14	100
1912-13	39	23	62	19	5	14	100
1913-14	36	25	61	18	5	16	100
1914-15	38	24	62	18	5	15	100
1915-16	33	35	68	14	6	12	100
1916-17	30	40	70	11	6	13	100
1917-18	20	55	75	10	7	8	100
1918-19	22	55	77	9	6	8	100
1919-20	31	35	66	14	8	12	100

It is difficult to over-estimate the importance to be attached to the fuel item in costs, as in some cases this amounts to nearly 80% of the works costs. Capital charges per unit sold definitely vary in inverse ratio to the output from any given plant, but although a fuller use of plant decreases the fuel consumption per unit, the effects are more complex, and under specified conditions beyond a certain point very little improvement can be expected. Diagram No. 2 has been prepared from actual figures to show how care in the purchase of fuel and the use of more efficient plant have been outbalanced by the enormous rises in the price of coal during the past few years. It may be noted that the average quality of the coal used was reducing during the years taken, and towards the last period was about 25% lower than in the first year or two. Diagram No. 3 shows how the increases have altered the proportion of expenditure under each head to the whole.

The rises in the price of coal have not been based on a percentage of the pre-war price, but on a flat rate per ton, with a tendency to level the prices to industrial users. This has brought about a peculiar result in throwing a proportionately heavier burden on those undertakings that before the war were fortunate enough to obtain a cheap supply of good coal: such undertakings have suffered for their past successes and no doubt have experienced difficulty in satisfactorily meeting the position.

In one Undertaking whose figures the writer has analysed it was found that while in 1915-16 the total revenue expenses on all items, including approximately 40,000 tons of coal, amounted to just over £60,000; in 1920-21 the cost of coal purchased, just about 40,000 tons again, alone exceeded £60,000! It was a good thing (to say the least of it) for that Undertaking to be able in 1920-21 to generate almost 8,000,000 more units with a rather smaller total quantity of coal than was used in 1915-16, by means of which economy no less than £28,000 was saved on this one item. Such instance provides a particularly apt illustration of one of the main effects of modernising plant.

Labour is an important item, not so much because of its relative heavy expense, but on account of the numerous ways in which leakage and waste may occur. The employment of men suitably trained and efficient in the discharge of their

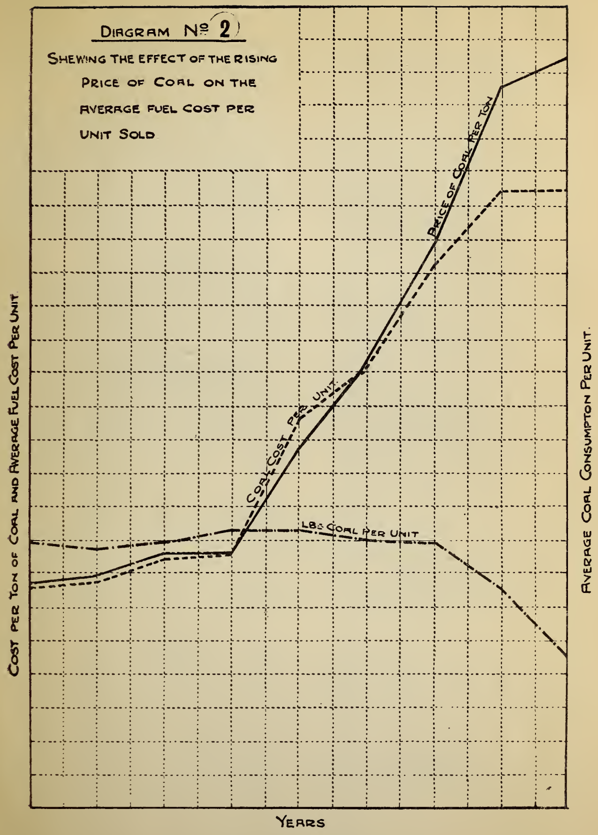
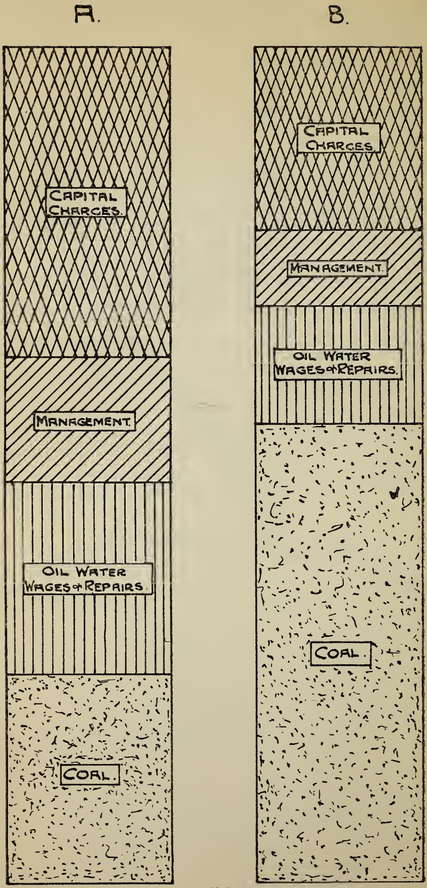


Diagram No. 2

Shewing the effect of the rising Price of Coal on the Average Fuel Cost per Unit Sold

Diagram No. 3.


A.
B.
CAPITAL CHARGES.
MANAGEMENT.
OIL WATER WAGES & REPAIRS.
COAL.
CAPITAL CHARGES.
MANAGEMENT.
OIL WATER WAGES & REPAIRS.
COAL.

duties is necessary. There would seem to be a tendency to cut down supervision rather too much, and stress is laid upon the benefits and increased economy to be obtained by the provision of sufficient officers and foremen properly to check and direct the large number of operations in a supply undertaking.

It has been stated that the principles underlying the cost of production of electrical energy do not differ fundamentally from those present in most other manufacturing businesses. This appears to be true if the effect of output upon overhead charges only is taken into consideration, but a closer analysis reveals vital differences.

> An electricity undertaking must at all times continuously be in a position immediately to meet the demands made as these occur, and as electricity cannot be economically stored in large quantities, the largest demand at any one time has to be covered by equivalent plant. Manufacturers of goods, on the other hand, can produce at a more or less uniform rate and use stock to protect their plant against the effects of irregular and variable demands, thus making it possible to meet requirements by plant equal to the averaged output. Further, a manufacturer can extend delivery.
>
> Distribution in electricity supply is abnormal, as the cost of this is a high percentage of the total cost ; the means of delivering supply are not mobile, and cannot be transferred or extended in the same way as is usually possible to meet different requirements in different parts of an area as demands vary.
>
> There is a great difference of degree. The standing charges in electricity supply, which with a given load or service demanded are practically irreducible, form something like 65 to 80 per cent. of the total expenditure, depending upon prices of the various components, etc. A manufacturer can in times of reduced output bring down expenses very much by discharging labour and by shutting down plant.

Thus it would appear that classification or grading of prices on the usual commercial lines will not meet the whole of the conditions so as to produce the best results. The question is perhaps somewhat complicated by the legal provisions relating to charges, which may be briefly summarised as follows :—

1882 Act:

Section 19:

Where supply is given in any part of an area, every consumer is entitled to a corresponding supply under similar circumstances on same terms as other consumers *in that part of the area.*

Section 20:

In making agreements, *undue* preference may not be given to any consumer, and the maximum prices may not be exceeded.

1899 Act:

Section 31:

Charges to any ordinary consumer may be :—

(1) By amount of energy;

(2) By the electrical quantity;

(3) By any other method approved by the Board of Trade;

but a consumer may, if he objects to any charge made under Item 3, by a month's notice in writing *require to be charged under Item* 1 *or* 2.

If the Local Authority is the undertaker, before commencing supply through any distributing main, it must publicly advertise the method of charging, which shall not be altered thereafter except after one month's notice.

Section 32:

Prices charged not to exceed maximum specified in schedule. Provision for revision of prices where the Local Authority is *not* the undertaker.

Section 33:

Subject as above, agreements may be made as to prices for supply and mode of ascertaining the charges.

1909 Act:

Section 15:

Consumers requiring a standby supply, to pay such minimum annual sum as will give a *reasonable return* on the capital expenditure involved *and meet other standing charges.*

The ordinary principles of business, which allow freedom for the operation of economic laws, and any adjustments necessary upon consequent effects, have by these provisions been rendered somewhat inapplicable in practice in framing tariffs. Section 19 of the 1882 Act is probably wide enough to enable any reasonable case to be met, but the uncertainty that has prevailed as to the meaning of Section 20, which prohibits undue preference, has provided fertile matter for discussion and contention, and has tempted the opponents of electricity supply interests into active operations in attempts to secure narrow and fettering legal decisions with a view to crippling electrical enterprise, contrary, it is believed, to the intention of the clause. The question has been brought to an issue by the decision of Mr. Justice Astbury in what is known as the Hackney Test Case; the interpretation is that the reason for different charges must be different costs, and it is now abundantly clear that differentiation may be made in relation to cost. The means adopted to meet the conditions were treated from a legal point of view by Mr. Justice Sargent in the case Attorney-General v. Long Eaton Urban District Council. This judgment laid down that the charge for supply must in equity be based upon the cost, and this now seems the only tenable ground upon which a defence of any particular method of charging can be put up with any chance of success. In the course of judgment it was said: "It would seem that A must not be charged less than B, merely to overcome a greater reluctance on the part of A to become a customer, or to induce A to become a customer in respect of another supply, although either of those reasons might be a good commercial reason for charging less to A *were the public undertakers merely carrying on any ordinary commercial business.*" Undue preference, in the sense that supplies which cost less are sold at higher prices and supplies which cost more are sold at lower prices, is shown in the commercial world, the justification put forward being that when the cost of production of anything is affected by the production of other things, the best way to develop the business as a whole is to adapt prices as fully as possible to the character of the demand.

The total revenue expenditure of an electricity supply undertaking does not depend upon, and has no necessary relationship to, the actual number of units generated and sold. Expenses are mainly incurred on the obligations imposed by the consumers' exercise of rights under statute, or, by the services undertaken. Thus a definite expenditure has to be met, though no advantage whatever be taken by the consumer of the facilities provided, and additional costs arise when supply is actually taken, to procure the extra assistance and materials necessary to produce. Consequently, it is only possible to obtain a true analysis of costs by dividing the expenditure into two groups, viz.: the Running Costs, embracing items that vary with output; and the Standing Expenses, covering all other items. Unfortunately while the legal decisions quoted make it clear that prices must be based on costs, Sections 31 and 32 of the 1899 Act completely overlook the facts of the matter. The third provision under Section 31 enables a just tariff to be put into operation, if sanction be obtained, but the right of consumers to be charged at their option by the amount of energy or electrical quantity renders it impossible to secure a reasonable return in many cases.

The schedule mentioned in Section 32 is usually as follows:—

> Where the undertakers charge any consumer by the actual amount of energy supplied to him, they shall be entitled to charge him at the following rates per quarter: For any amount up to twenty units, thirteen shillings and fourpence; and for each unit over twenty units, eightpence.

When powers relating to a public utility are granted, a clause is usually inserted to control prices, and a maximum limit defined. This seems quite proper, if two conditions are met by the clause:—

(17) It must be effective, and protect consumers against unduly high prices.

(18) It must enable undertakers to recover the expense of supplying.

The schedule quoted meets neither of these conditions, and has during the past few years created hardship in a number of undertakings. It was framed thirty years or so ago, doubtless to meet the case of lighting consumers having regard to conditions and experience at the time; to-day it is incapable of protecting a large number of important consumers from prices that could not stand against competition, and it operates very unfairly in view of the obligations placed upon undertakers to supply. Thus, in protecting consumers as a whole from an excessive burden its usefulness is strictly limited. Undoubtedly the clause is out of date and requires revision to enable it to be effective, and to prevent the possibility of numerous demands that have to be met at a certain loss, which loss has to be made good by increased charges to other consumers, the result being to hinder general progress. Special or individual expenditure is necessary on behalf of consumers, by way of service lines, etc. (which cannot be productively employed if the consumers concerned do not use them), and interest and other standing charges on these special provisions are incurred; accordingly it seems only reasonable that an adequate return should be secured against such charges.

If such a provision were made, the charges for supply taken would be based upon and governed by the general costs in the undertaking, which could then be fairly allocated between the different classes of consumers. The principle to be adopted has legal sanction in Section 15 of the 1909 Act, and, further, the Government itself has found it necessary to frame its charges for the telephone service on these lines.

The proper provision to meet the conditions experienced is a multipart tariff, and if approved and generally adopted this would be the means of removing some of the injustice now present.

It would appear that price control is most effectively carried out by:—

(19) Competition.

(20) The influence of unduly high prices upon output and progress.

(21) Limitation of profits.

A reasonable amount of fair competition is necessary to secure the well being of any industry, and to protect its customers against unwarranted prices. That competition is present against electricity in the shape of gas, oil, private plants, etc., and is so universally met with by engineers in their endeavours to secure new custom, that the point needs no elaboration. High prices are suicidal as they prevent increased output, drive customers to the use of competitive products, and restrict the range of usefulness of the utility, so preventing its popular adoption and the creation of valuable diversity of load. The principle that price should be adjusted to meet competition and cost will adjust itself to price, cannot be unreservedly supported; yet it contains an element of truth because of the large influence of price upon output and of output upon cost.

Prices of fuel and other items, rates of wages, and rates of interest, etc., on capital, have their effect on electricity supply as on other industries, although not in the same way or to the same extent. Given these prices and rates and the efficiency conditions obtaining, however, the following technical considerations have a definite effect on the cost of production:—

(22) The utility factor of the station.

(23) The period during which supply is taken.

(24) The load factor.

(25) The diversity factor.

(26) The magnitude of the consumption.

(27) The proximity of the consumer's premises to the generating station.

(28) The power factor.

The analysis of costs was dealt with in a brilliant manner by Dr. John Hopkinson and Mr. Arthur Wright nearly thirty years ago. The principles enunciated by these writers are the foundation of electro-economics, and have been of incalculable service; it has not since been found possible to improve upon the fundamentals laid down. The problems to be met in connection with charges were, however, much simpler in the early days of the industry, as supply then consisted almost wholly of one commodity—lighting: to-day, when supply is applied to many purposes having widely different effects on the plant by reason of differences in demand, load factor, and diversity factor; requiring large variations in the capital expenditure on distribution; and at the same time having different service values, an extended analysis is necessary to arrive at a satisfactory allocation of costs.

To regard an undertaking as a whole and ascertain the average costs on the basis of the total units sold and the peak load on the generating station is not satisfactory, as the Running Costs vary with different classes of supply, and all the Standing Expenses are not proportional to the peak load. There are three types of supply in most undertakings :—

(29) High tension, alternating current, requiring only feeding mains. Losses, say 5%.

(30) Low tension, alternating current, requiring transformers, feeding mains, and distributing mains. Losses, say 15%.

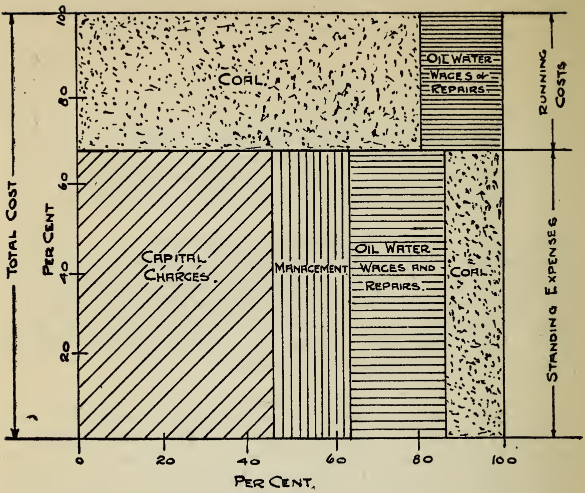
(31) Low tension, direct current, requiring transformers, converters, feeding mains, and distributing mains. Losses, say 25%.

and each of these has widely varying costs in any given undertaking. While a large portion of the generating standing expenses can be fairly allocated on the basis of peak load, on the other hand distribution costs require different treatment, and transformation and conversion costs only apply to a particular class of supplies. The management expenses largely depend upon the number of consumers.

Probably the most generally used method of analysing costs of supply is that given in the Report of the Joint Committee of the Incorporated Municipal Electrical Association and the Incorporated Municipal Tramways Association, issued in 1912, although this can only be said to lay down a broad scheme on accepted principles. The alterations suggested under the heading of General Notes, and the reservations made, indicate that with no degree of certainty can the formula given be applied and relied upon to produce the actual costs of any supply at any time from any generating station. This, it is believed, was not intended, although cases have arisen where that construction has been placed upon the Report.

Diagram No. 4 has been constructed, from figures in an Undertaking selected, to show the distribution of expenditure as between Standing Expenses and Running Costs, and the relative importance of the items comprising these. Diagram No. 5 is put forward to show how these two portions of the costs are built up from various sections, sub-sections and items in the total expenditure.

Diagram No. 4.



The Running Costs are the simplest factor, being directly proportional to output, but they cover very important items, and the following points are worthy of notice as having a considerable influence on the results :—

(32) Selection of fuel.

(33) Efficiency of plant in operation.

(34) Utilisation of plant to meet the load.

(35) Careful maintenance.

(36) Employment of suitably trained labour.

The Running Costs are a serious matter in large and high load factor supplies, and often determine the possibility or otherwise of securing business; as the load factor increases, the percentage of the running costs to the total costs becomes greater.

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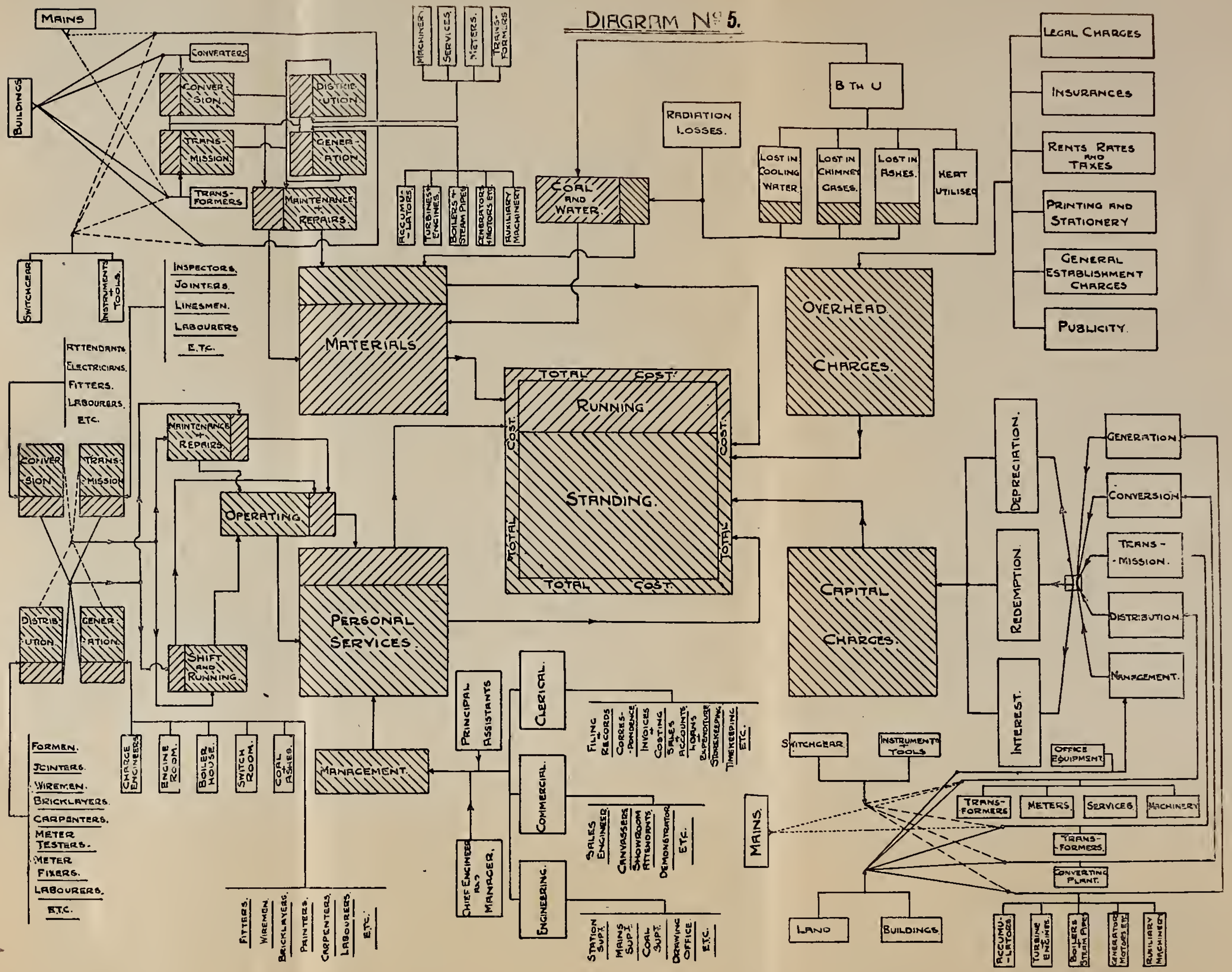
The Standing Expenses are more or less fixed in a given Undertaking, and are largely decided by the magnitude of the load to be met, the geographical character of the area, and the number of consumers. Each of these factors affects the liabilities to be incurred, and the variation of their relative importance in different areas makes it impossible to judge fairly between the achievements in different undertakings unless proper attention be paid to them. For all that, the burden is to an extent under control. Skill and knowledge in the design of stations and distribution systems, and the most economical methods of finance, will tell in the capital charges to be met; coal, oil, water, repairs and labour can be reduced by good management and by the use of the most efficient plant and its best arrangement; while management is made most effective by the engagement of suitable staff and the use of up-to-date methods.

Load factor is extremely important, because the output of a given station can be increased enormously, by keeping the plant more fully loaded throughout the day, without affecting the Standing Expenses. This has a marked effect on the average total costs per unit. It is rather a mistake, however, to think that load factor pure and simple will do all that is desirable. It is quite possible to improve the load factor and yet actually increase the average costs per unit, and the writer has known such cases in practice. The improvement must come about in any given plant with a maintained or increased maximum demand. If the maximum demand is decreased, the effect of a higher load factor may be more than neutralised by the lessened output. Further, a given load factor may be produced by widely varying conditions, as illustrated by the load curves. The only expenses that are really invariable are the capital charges, and that portion of the operating costs which does not depend on output may be larger or smaller by reason of the characteristics of the load. A demand fairly steady throughout but with a pronounced peak in one period will prove more economical to meet than an irregular demand with the same maximum and the same output. With zero load factor all costs are Standing Expenses, while with unity load factor all expenditure becomes Running Costs: between these two extremes the division varies with different load factors, and any scale of charges should compensate for this variation. An increase in load factor will diminish the difference between, DIAGRAM No. 5.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METERS
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ACCUMULATORS
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BOILERS + STEAM PIPES
GENERATORS + MOTORS ETC.
AUXILIARY MACHINERY
COAL AND WATER
RADIATION LOSSES.
B TH U
LOST IN COOLING WATER
LOST IN CHIMNEY GASES.
LOST IN ASHES.
HEAT UTILISED
LEGAL CHARGES
INSURANCES
RENTS RATES AND TAXES
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CANVASSERS
SHOWROOM ATTENDANTS
DEMONSTRATOR
ETC.
STATION SUPT.
MAINS SUPT.
COAL SUPT.
DRAWING OFFICE
ETC.
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MAINS.
TRANSFORMERS
METERS
SERVICES
MACHINERY
TRANSFORMERS.
CONVERTING PLANT.
LAND
BUILDINGS
ACCUMULATORS
TURBINE ENGINES
BOILERS + STEAM PIPES
GENERATORS MOTORS ETC.
AUXILIARY MACHINERY

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Load factor is extremely important, because the output of a given station can be increased enormously, by keeping the plant more fully loaded throughout the day, without affecting the Standing Expenses. This has a marked effect on the average total costs per unit. It is rather a mistake, however, to think that load factor pure and simple will do all that is desirable. It is quite possible to improve the load factor and yet actually increase the average costs per unit, and the writer has known such cases in practice. The improvement must come about in any given plant with a maintained or increased maximum demand. If the maximum demand is decreased, the effect of a higher load factor may be more than neutralised by the lessened output. Further, a given load factor may be produced by widely varying conditions, as illustrated by the load curves. The only expenses that are really invariable are the capital charges, and that portion of the operating costs which does not depend on output may be larger or smaller by reason of the characteristics of the load. A demand fairly steady throughout but with a pronounced peak in one period will prove more economical to meet than an irregular demand with the same maximum and the same output. With zero load factor all costs are Standing Expenses, while with unity load factor all expenditure becomes Running Costs: between these two extremes the division varies with different load factors, and any scale of charges should compensate for this variation. An increase in load factor will diminish the difference between, or tend to make equal, the Standing Expenses and Running Costs, and at a certain point these would be the same. Diagram No. 3 was originally prepared to illustrate the effect of the increase in the price of coal during recent years, but it gives a good idea of the altered composition of costs with an increased load factor.

Utility factor has an effect on the average costs, and completes the picture only partially presented by load factor in bringing out the effect of the plant necessary as spare, or not utilised, at different stages of development. Omitting the question of thermal and economic characteristics, the following figures show the effect produced on the capital charges per unit by an alteration in utility factor :—

Item.	Station No. 1.	Station No. 2.
Plant Installed	Two 5,000 Kw. sets	Two 5,000 Kw. sets Four 10,000 Kw. sets
Maximum Demand	5,000 Kw.	35,000 Kw.
Utility Factor	.25	.28
Output in Units	22,000,000	122,000,000
Load Factor	50%	40%
Capital Expenditure	£200,000	£1,000,000
Interest and Repayments	£20,000	£100,000
Capital Charges per Unit	.218d.	.197d.

Divergence in the demand periods is valuable, as this enables more load to be met from a given plant than would be possible if all the demands made coincided, thus reducing the commitments on plant and mains in respect of individual demands. although this advantage is lessened by the additional expenditure necessary to extend the number of consumers. Experience proves that in normal circumstances an undertaking will only be called upon to supply 50% to 60% of the consumers' installed lamps, motors, heaters, etc., at any one time, and the figure is being reduced as domestic supply develops.

A high diversity factor is an effective means of improving the load factor, and the two are closely related. As it is only practicable to deal with classes of consumers, except in large and special cases, each consumer will receive the benefit of the diversity of demand within the class to which he belongs. The division of load making up the peak demand between the classes having been ascertained, then the ratio of the sum of the individual demands in any of the classes to the combined demand of that class will determine the benefit to be obtained. This benefit is much greater in some classes than others, and it has been estimated (although opinions and experience on this point differ) that the diversity factor of different loads is in the following order:—

Lighting	1.1 to 1.5,	average probably 1.25
Power	1.5 to 3.0,	average probably 2.00
Heating and Cooking	4.0 to 10.0,	average probably 7.00

The period during which supply is taken is a point that should receive full attention, as by arranging for load during the times of light demand to fill in the valleys in the load curve, both diversity factor and load factor can be increased. A consumer with a 25% load factor may, if his demand is made and maintained during the off peak periods, be more profitable than one with 100% load factor, in which case the demand would of necessity be maintained during the peak period. One hundred per cent. load factor consumers are undoubtedly entitled to very low rates of charge, as such a load has a big effect on the average overhead expenses, but there would seem to be even better propositions. A good consumer with an off peak demand can be profitably supplied at a surprisingly small price per unit.

There are great possibilities of saving by a re-arrangement of working hours to flatten the peak load, an attractive alternative to securing off peak custom.

Power factor is a matter that is becoming more and more serious in its effect upon the cost of supply due to the reduced effectiveness of plant, transformers, and mains where this is low. With the present inflated prices no undertaking can afford to ignore the resultant decrease in efficiency brought about by low power factor supplies. To provide plant, etc., and then be able to utilise it only to a fractional extent of its capacity is a very costly procedure, and steps have to be taken to improve the power factor or to vary the charges in inverse proportion. In practice it is admittedly difficult to deal with the question by trying to take care of individual consumers, and therefore the costs to be met should be allocated on the basis of the current and declared pressure, varying the expense in such a way that it will pay the consumer to take a serious interest in the question and to provide the best type of machinery and most efficient arrangements. The increased costs to carry out given work are so heavy when the power factor is low that the most effective correction can probably be obtained if these are properly allocated and charged.

Results have been so obscured by the unstable conditions during the past five or six years, that it is difficult to put forward a series of up-to-date figures taken from actual practice which will be helpful, without serious compensation, but the comparative analysis of the figures relating to the Undertaking with which the writer is connected, given in Table No. 1, is instructive. These figures are worthy of careful study, as they bring out very well the effect of various factors that have been briefly dealt with. The danger of considering an undertaking as a whole or in using averages based on the output in units, is clearly shown by the curves in Diagram No. 6, which represent the costs of production in the two years dealt with. The space between the years has been used to show the proportionate increases in three main items of cost in the year 1918-19 compared with the year 1914-15. The second and higher curve in the year 1918-19 shows the costs for that year as they would have been had the conditions obtaining in 1914-15 continued with the rises in prices, rates of wages, etc., actually experienced; the space between the curves measures the savings effected. Diagram No. 6a reproduces the three curves shown in Diagram No. 6, but plotted with logarithmic ordinates. These curves bring out the effect of varying increases in the different items of cost on different load factor supplies, and the need for care in the allocation of such increases to each class of consumer.

Regard has to be had to questions of expediency in framing tariffs, and an extensive range of argument can be brought forward to support a variety of views on this matter. The

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Table No. 1.

Item.	Year 1914-15.	Year 1918-19.
A. CAPITAL.		
1. Gross Capital Expenditure.	£347,260	£575,201
2. Capital Outstanding.	£191,190	£343,854
3. Item 2 to Item 1.	55%	60%
Increase due to large extensions to meet load and provision of more efficient plant in generating station.		
4. Plant Installed.	7,280 kw.	23,500 kw.
5. Capital Expenditure per Kw. Installed.	£47·7	£24·5
6. Capital Outstanding per Kw. Installed.	£26·3	£14·6
Benefit of increase in load on Capital Expenditure is pronounced.		
B. OUTPUT.		
7. Units Generated.	16,750,620	40,651,153
8. Units Sold.	13,126,271	34,103,501
9. Units Sold to Generated.	78½%	84%
Higher efficiency due to extended sales of A.C.		
10. Units Sold per Head of Population.	131	340
11. Approximate Division of Sales:—		
a. Consumers up to 12% load factor.	16%	5%
b. Consumers over 12% and up to 25% load factor.	46%	27%
c. Consumers over 25% and up to 40% load factor.	23%	12%
d. Consumers over 40% and up to 80% load factor.	15%	56%
Effect of alteration in character of output shown in costs.		
12. Peak Load	6,260 kw.	10,600 kw.
13. Average Load Factor.	30·55%	43·79%
C. WAGES AND PRICES.		
14. Rates of Wages.	Normal.	Increased 120%
15. Prices of Repair Materials, etc.	Normal.	Increased 230%
16. Price of Coal and Slack.	Normal. (7/- ton.)	Increased 248% (24/4½ ton.)
Very heavy increases in wages and prices of fuel and other materials.		
17. Tons of Fuel Consumed.	32,007	67,465
18. Average Fuel used per Unit Generated.	4.656 lbs.	3.764 lbs.
Effect of more up-to-date plant and larger sets is apparent.		

Item.	Year 1914-15.		Year 1918-19.	
D. COSTS OF PRODUCTION.	d. per Unit Sold.	% to Total.	d. per Unit Sold.	% to Total.
19. Costs:—				
a. Fuel.	·220	24	·582	55
b. Oil, Water, Wages and Repairs.	·134	15	·127	12
c. Distribution.	·073	8	·025	3
d. Management.	·136	15	·089	8
e. Capital Charges.	·347	38	·232	22
Total	·910	100	1·055	100
20. Total Revenue Expenditure.	£49,746		£150,006	
Total average cost per unit only increased 16% despite greatly enhanced wages and prices of fuel and other materials.				

Item.	Year 1914-15.	Year 1918-19.
E. REVENUE.		
21. Gross Revenue from Sale of Electrical Energy.	£55,685	£166,689
22. Gross Revenue to Gross Capital Expenditure.	16%	29%
23. Gross Revenue to Capital Outstanding.	29%	48%
Influence of increased turnover is shown in several items.		
24. Average price per Unit Sold.	1·018d.	1·173d.
Total average price per unit required only increased 15%.		
25. Gross Profit.	£24,913	£49,663
26. Gross Profit to Capital Expenditure.	7·2%	8·6%
27. Gross Profit to Capital Outstanding.	13%	14·4%
28. Gross Profit to Gross Revenue.	44·7%	29·8%
29. Surplus.	£5,959	£16,683
30. Surplus to Capital Expenditure.	1·7%	2·9%
31. Surplus to Capital Outstanding.	3·1%	4·8%
32. Surplus to Gross Revenue.	10·7%	10%
The surplus given is the unappropriated balance after payment of all interest and redemption contributions.		

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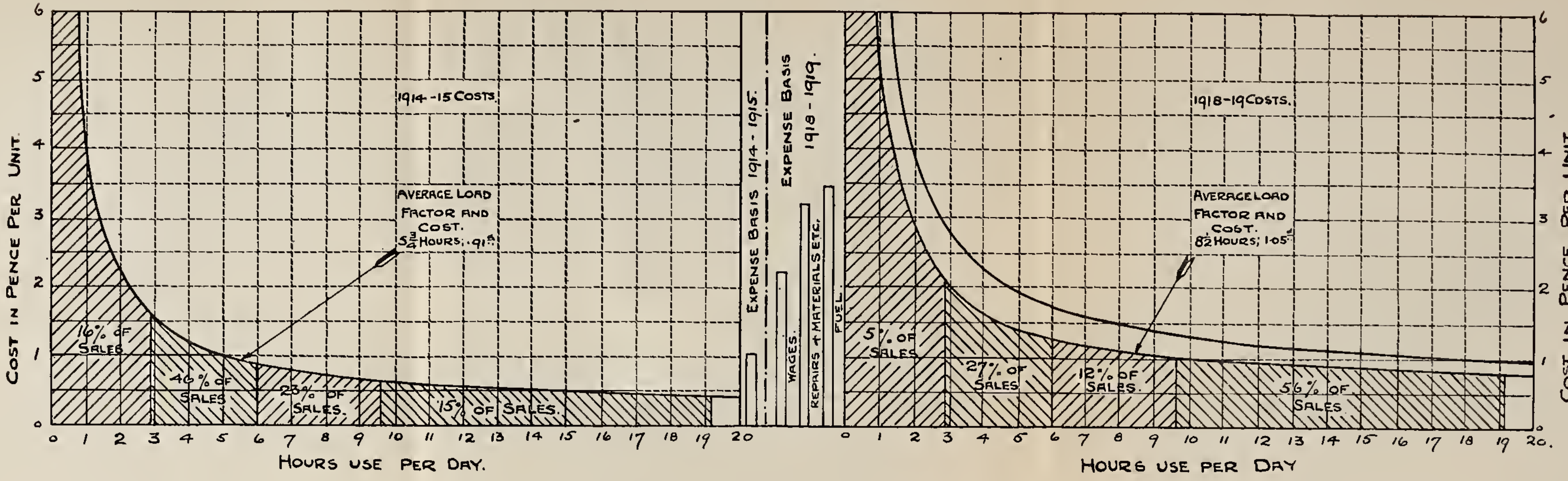
DIAGRAM No. 6

COMPARISON OF COSTS IN 1914-15 AND 1918-19 WITH ALTERED CONDITIONS AND PRICES ETC.



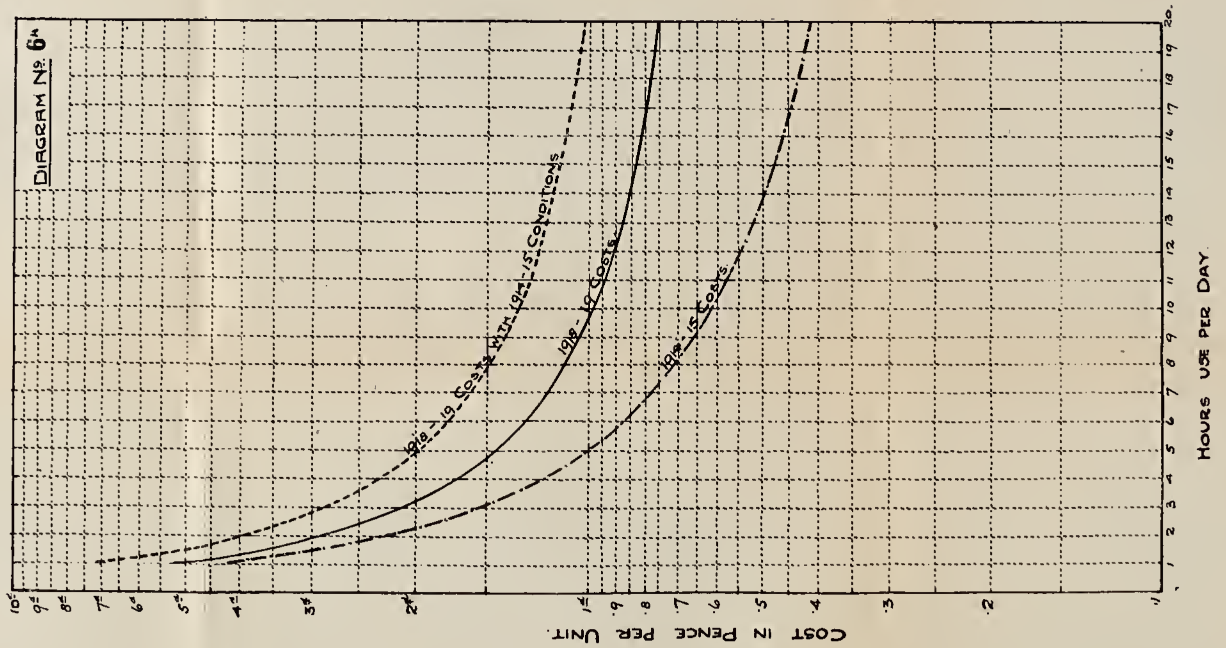


DIAGRAM No. 6A

points arising are very numerous, and it is not possible adequately to compensate for all the different factors, technical, economic and expedient.

The phenomenon known in economics as the law of diminishing utility (which, briefly stated, shows that the total utility of a commodity to a consumer increases with the increases in the amount he can get, but not at the same rate) is of particular interest. A curve representing this law has a close similarity to a curve representing the cost of production of electrical energy, thus proving the necessity of constructing a tariff on the general lines indicated. Diagram No. 7 makes this clear, and the comparison is instructive. Translated into terms of price, this economic law means that, although a consumer may be willing to pay, say, eightpence per unit for 100 units per annum, he would not, other things being equal, continue purchases beyond this amount at the same rate of charge; to induce him to purchase 1,000 units it may be necessary to reduce the average price by half. An illustration might be useful. Take the case of a shop requiring supply for lighting, which purpose can be served by consuming 240 units per annum: the owner will be prepared to pay a certain amount for this service, say £6, or sixpence per unit, but for supplies for special purposes beyond actual requirements during darkness, this price must be reduced. It might be an exceedingly good proposition to light windows after closing hours for advertising purposes at, say, twopence per unit, but this would probably represent the marginal utility of the extra supply. Above that figure there would be no demand.

In economics there is one general law of demand: the larger the output the smaller must be the average price to dispose of it, although there is no direct relation between a reduction in price and an increase in output. A small movement may bring about big increases or reductions.

This brings one to elasticity of demand, which has a bearing on the question, especially in view of the variety of uses to which electricity is nowadays put. It has been shown that a person's desire for supply will probably diminish with the increased quantity available, but this decline may be slow or rapid: if it is slow, the reduction in price to induce purchase need only be small, while if it is rapid, the reduction

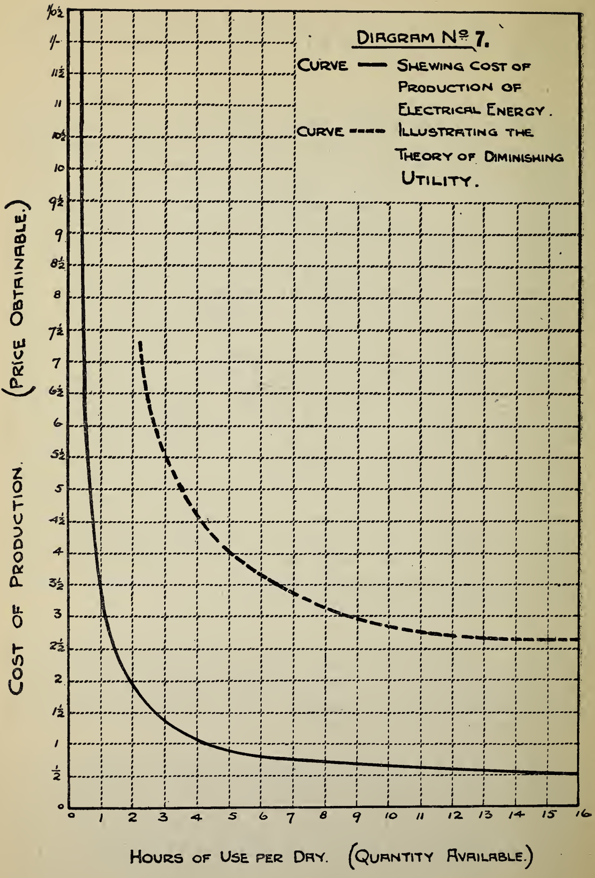


Diagram No. 7.
Curve —— Shewing Cost of Production of Electrical Energy.
Curve - - - - Illustrating the Theory of Diminishing Utility.
Cost of Production. (Price Obtainable.)
Hours of Use per Day. (Quantity Available.)
1/0½
1/-
11½
11
10½
10
9½
9
8½
8
7½
7
6½
6
5½
5
4½
4
3½
3
2½
2
1½
1
½
0
0
1
2
3
4
5
6
7
8
9
10
11
12
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14
15
16

must be a large one; in the first case the demand will prove to be elastic, but in the latter case it will not. The action applies conversely to an increase in prices. This principle may be applied in considering a domestic consumer who uses supply for lighting only, and who might be quite willing to extend its application to other purposes if a sufficient reduction is made, depending upon the savings that could be effected by disposing of domestic assistance, etc., and the extra comfort and leisure resulting.

The writer places as of first importance the division of consumers into classes. This has generally been settled up to now by differentiating between power, lighting and heating. It is open to question, however, whether this crude but commercial division is the right one, and whether the results brought about by it are as satisfactory as they might be. True, it is justified in so far as the amount taken by, the load factor, etc., of these classes differ greatly, but no sound argument (other than that of expediency) can be brought forward for supplying power, as such, at a lower price than lighting. It is recognised that the utility values of the different services given by electricity are not the same, and that to a large extent these values are determined by the competition of other means of providing the assistance required. Thus lighting is a more valuable commodity than power, and will stand a higher price, but owing to the reducing percentage of the portion of the output for this purpose, the older view that stations are established for lighting, which therefore should be allocated with a large proportion of the standing expenses, is fast becoming untenable. The day has now arrived when consumers who use the supply solely for lighting should be few (as indeed obtains in some towns), and the introduction of a multiplicity of useful and desirable appliances both for business and domestic use has brought the industry to a stage when a broad outlook unprejudiced by the past seems necessary to make the most of the position.

The size of the consumer has an important bearing on the cost of supply, as the standing expenses vary considerably for a given output if it be taken by a few large or many small consumers, and in view of the foregoing remarks the analysis in Table No. 2 is submitted on these lines. This analysis is recognised to be incomplete, as several variables that are often present have not been introduced, for example, the effect of diversity factor within the classes of consumers, but it is not possible to extend it in a general paper of this kind, and it is put forward as a practical improvement on the usual method of treating an undertaking as a whole.

The division of the expenditure into Standing Expenses and Running Costs has been made on the basis of the total average load factor, dealing separately with each of the items shown; and the allocation of the Standing Expenses between the different classes of consumers then arrived at as follows:—

Capital Charges:

Generation.—Interest and repayments divided on the basis of the peak load.

Distribution.—Interest and repayments divided proportionately.

Expenditure £40 per consumer for No. 1 Class.
£100 per consumer for No. 2 Class.
£1,000 per consumer for No. 3 Class.

Operating Charges:—

Generation.—Coal, on basis of overall consumption at different load factors.

12% load factor 5.00 lbs. per unit sent out.

25% load factor 2.75 lbs. per unit sent out.

40% load factor 2.25 lbs. per unit sent out.

Two lbs. per unit. have been taken for running costs, the difference between this figure and the above being the standing charge to each class.

Water, Oil and Stores, in same proportion as Coal.

Repairs and Labour, on basis of maximum demand, credit being given for economies resulting from large and high load factor supplies.

Distribution.—On basis of number of consumers, maximum demand, and mains required.

Management Charges:—

Local rates, divided in proportion to the Capital Expenditure necessary for each class.

All other items allocated on the basis of the number of consumers and units sold.

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Capital Charges:

Generation.—Interest and repayments divided on the basis of the peak load.

Distribution.—Interest and repayments divided proportionately.

Expenditure	£40	per consumer for No. 1 Class.
	£100	per consumer for No. 2 Class.
	£1,000	per consumer for No. 3 Class.

Operating Charges:—

Generation.—Coal, on basis of overall consumption at different load factors.

12% load factor 5.00 lbs. per unit sent out.

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Water, Oil and Stores, in same proportion as Coal.

Repairs and Labour, on basis of maximum demand, credit being given for economies resulting from large and high load factor supplies.

Distribution.—On basis of number of consumers, maximum demand, and mains required.

Management Charges:—

Local rates, divided in proportion to the Capital Expenditure necessary for each class.

All other items allocated on the basis of the number of consumers and units sold.

Table No. 2.

A. CAPITAL EXPENDITURE.

Generation:—		£400,000
Distribution—For No. 1 Consumers	£120,000	
For No. 2 Cousumers	£50,000	
For No. 3 Consumers	£40,000	
		£210,000
TOTAL		£610,000

B. OUTPUT, Etc.

Class of Consumer.	Number of Consumers.	Division of Peak Load, Kw.	Units. Sent out.	Units. Sold.	Losses.	Load Factor (approx.)
No. 1.	3.000	2,000	2,650,000	2,000,000	25%	12%
No. 2.	500	5,000	11,750,000	10,000,000	15%	25%
No. 3.	40	8,000	29,480,000	28,000,000	5%	40%
Total	3,540	15,000	43,880,000	40,000,000	8⅔%	30%

C. REVENUE EXPENDITURE.

	£	£	Average per Unit Sold.	
Generation—Coal.	62,000		·372	
Oil, Water and Stores.	1,500		·009	
Wages and Repairs.	14,500		·087	
		78,000		·468
Distribution—Wages, Repairs, etc.		8,000		·048
Management.		12,000		·072
Capital Charges.		52,800		·317
TOTAL		£150,800		·905

D. DIVISION OF EXPENDITURE.

	Standing Expenses. £	Running Costs. £	Total. £
Generation—Coal.	12,000	50,000	62,000
Oil, Water and Stores.	500	1,000	1,500
Wages and Repairs.	9,000	5,500	14,500
Distribution—Wages, Repairs, etc.	6,500	1,500	8,000
Management.	12,000	—	12,000
Capital Charges.	52,800	—	52,800
TOTAL	£92,800	£58,000	£150,800

E. ALLOCATION OF COSTS.

Standing Expenses.

Class of Consumer.	Capital Charges. Generation. Total. £	Capital Charges. Generation. Per Kw. £	Capital Charges. Distribution. Total. £	Capital Charges. Distribution. Per Kw. £	Operating Charges. Generation. Total. £	Operating Charges. Generation. Per Kw. £	Operating Charges. Distribution. Total. £	Operating Charges. Distribution. Per Kw. £	Management. Total. £	Management. Per Kw. £	Total Expenses. Total. £	Total Expenses. Per Kw. £
No. 1.	4,800	2·40	9.600	4·80	7,300	3·65	3,500	1·75	5,000	2·5	30.200	15·10
No. 2.	12,000	2·40	4,000	0·80	7,350	1·47	2,000	0·40	4,500	0·9	29.850	5·97
No. 3.	19,200	2·40	3,200	0·40	6,850	0·856	1,000	0·125	2,500	0·312	32,750	4·093
TOTAL.	£36,000	£2·40	£16,800	£1·12	£21,500	£1·43	£6,500	£0·43	£12,000	£0·80	£92,800	£6·18

Running Costs.

	£	£	Average per Unit Sent Out.	
Generation—Coal.	50,000		·273	
Oil, Water and Stores.	1,000		·006	
Wages and Repairs.	5,500		·030	
		56.500		·309
Distribution—Wages, Repairs, etc.		1,500		·008
TOTAL		£58.000		·317

No. 1 Consumers ·317d., with 25% loss = ·423d. per unit.
No. 2 Consumers ·317d., with 15% loss = ·373d. per unit.
No. 3 Consumers ·317d., with 5% loss = ·334d. per unit.

F. COSTS FOR EACH CLASS OF CONSUMER.

No. 1. Class.

£15·10 per Kw. per annum + ·423d. per unit, @ 12% load factor, the average price per unit would be 3·871d.

No. 2 Class.

£5·97 per Kw. per annum + ·373d. per unit, @ 25% load factor, the average price per unit would be 1·027d.

No. 3 Class.

£4·093 per Kw. per annum + ·334d. per unit, @ 40% load factor, the average price per unit would be ·614d.

These work out:—

No. 1 Class at £1.67 per consumer.
No. 2 Class at £9.00 per consumer.
No. 3 Class at £62.50 per consumer.

Supply which never makes demands during the peak load period may be relieved of the generating station capital charges, and the contributions made towards the other standing expenses will generally prove sufficient to make such a consumer profitable. For example, a large consumer who is restricted to non-peak supply would be costed as follows:—

Standing Expenses .	£4.093 per Kw.	
Less	£2.400 per Kw.	(Generation Capital Charges).
Leaving a charge of	£1.693 per Kw.	

At a load factor of 40% the average cost per unit would be .450d.

The best general solution the writer has met with up to now, combining expediency and ability to meet the factors involved, is the multipart tariff. This is simply Dr. Hopkinson's "ideal method" of charging, viz., a fixed amount independent of use, and in addition a small price per unit metered. It is a great improvement on the maximum demand indicator system.

In multipart tariffs the standing charge is variously fixed on the installation, demand, number of rooms, rateable value, etc., and although it would appear unfair to assess this on any basis other than class of consumer and demand, it is well not to be too definite on the point. Every workable basis is open to some objection. There is one point certain, that to be generally acceptable the bases of charge for power and industrial users, business premises, and domestic consumers cannot be the same. With power and industrial users (usually a small number of large consumers) actual measurement of demand is practicable and worth while, and will do away with much uncertainty, while with business premises experience should enable the total connections to be used as a measure. Domestic consumers present an entirely different problem, but it should be possible to devise a scale on a simple basis that would meet the required allocation of Standing Expenses to this class of consumer. An important point is to bring the unit charge down as low as possible, and the writer has found a standing charge of 15% of the rateable value, with a follow-on charge of ½d. per unit, very popular. The consumer is content in the knowledge of his fixed amount, and realises that it does not pay to worry about the exercise of those petty economies which are pressing in the case of a flat rate. Consequently, output tends to grow rapidly, and general domestic devices come into use with good effect all round.

The following figures, covering a year's sales for residential supplies, show what effect can be produced upon output and revenue by the introduction of a multipart tariff :—

Item.	Flat Rates.	Multipart Tariff.
No. of Consumers	817	326
Units Sold	227,207	488,853
Revenue : —		
Standing Charge	—	£1,276
Unit Charge	£2,810	£1,019
Total	£2,810	£2,295
Average per Unit	2.97d.	1.13d.
Average per Consumer : —		
Units Sold	278.1	1,499.5
Revenue	£3.44	£7.04

One of the advantages of this method of charging is that it does away with the necessity of separate circuits and meters for different uses of the supply, enabling economies to be made both by the consumers and the supply authority in these items. This is a really important point, as the need for separate expensive wiring, to avoid prohibitive charges when it is desired to use small domestic appliances, has been an active deterrent against a more extensive use of these.

Multipart tariffs may possibly be the means of bringing about a general system of charging for all supplies, and this would appear to be the logical extension of the system. If so, then a tremendous step forward will have been made, and it will only rest with each consumer to make the most of the supply available to obtain full value for his money and an attractive average price.

The writer looks forward to the day when electricity will be put on tap and supplied without very great restriction for an inclusive figure per kilowatt per annum, independent of the number of units consumed. It would not be impossible, in the light of progress during the past few years, to arrive at such a stage, with consequent savings in many items included under distribution expenses.

SECTION 4.—Application of Revenue Earned.

Outlay on electricity supply has a low direct earning capacity, and the margin of safety is therefore very fine; great care is necessary, in view of the many factors involved, to obtain the best advantage under conditions existing, and to ensure that income is sufficient to meet all expenditure.

The ascertainment of revenue receivable is costly and dependent on instrument accuracy; accounts for supply being based on meter registrations, a small average error in these would largely affect the financial results.

The industry is particularly susceptible to loss resulting from even small reductions in output, due to a temporary trade depression, or a slight change of domestic requirements such as has been caused by the Summer Time Act.

Under these conditions freedom to utilise in the most beneficial way, or conserve, any small surplus that may be realised becomes of importance.

The usual clause inserted in Electric Lighting Orders relating to the application of revenue is on the lines of Section 7 of the Electric Lighting (Clauses) Act, 1899, and although a strong position is assured with these provisions in so far as the Section provides for :—

(37) A Reserve Fund with a definite limit;

(38) The investment of the Reserve Fund in outside securities;

(39) The allocation of surplus in relief of local rates;

(40) The meeting of any deficiency out of local rates;

and excludes provision for :—

(41) Renewals and Depreciation (apart from redemption measures);

(42) Working capital;

it falls short of present day requirements.

Reserve Funds.

There is probably no need to submit a full argument for the establishment of a reserve fund, adequate having regard to the size of the undertaking: such is absolutely necessary to financial stability and success, and a definite allocation from any surplus should be made accordingly. It is important to understand the essential difference between reserve funds and reserves, however, which lies in this: that a reserve is a charge made against revenue to provide for an expected loss, whereas a reserve fund is an allocation of surplus remaining available after payment of all charges, known and contingent.

It is recognised that the object of a municipal undertaking is not to make large profits. The service should be provided with as little margin over cost as may be financially safe, but the restrictions in the amount that may be set aside might be actually harmful in preventing wise provision which the authority and its consumers can well afford, and may even be anxious to make. A strong reserve fund exists in the majority of successful business concerns, and to make it difficult to accumulate such, when at the same time prices are kept reasonable by other factors, is not wise. An adequate reserve fund accumulated by the appropriation of surplus which is so small in any one year as to be of no material benefit to consumers if divided amongst them by a price reduction in that year, will hurt no one, and may be of great help in later on enabling energy to be sold more cheaply than would otherwise have been possible. The security provided against future contingencies would be very well worth the sacrifice of a small present enjoyment. An over-large accumulation that is not properly and productively employed to the benefit of the consumers in the long run is most unlikely.

There are cases where it is desirable, and necessary, to invest a reserve fund, and indeed a reserve, outside the business, but the idea prevalent in some quarters that the former, to be real, must be so invested is based upon a misconception which, it is trusted, has already been cleared in the difference shown above between these two items. It is possible to have investments outside an undertaking and yet be without a reserve fund, and, in fact, the existence of such always depends upon a surplus of assets over liabilities, and not at all upon any specific means of employing any particular assets or class of assets. The main question arising out of the management of a reserve fund is, "How can the corresponding surplus of assets be most suitably employed?" As an electricity supply undertaking

(43) has to meet practically a quarter's expenses before receiving its revenue from the sale of energy;

(44) is not empowered to borrow for Working Capital;

(45) as it is desirable constantly to meet the cost of small items of a capital nature, such, for instance, as meters, services, etc., out of revenue instead of borrowing;

and

(46) as expenditure is necessary to conduct experiments with a view to improvement and to further development,

the use of the fund for these purposes, amongst others, is clearly desirable.

Depreciation.

The question of depreciation in municipal undertakings is one on which there has been much contention, but the merits of the case have been somewhat disguised by reason of the inherent difference between private and public trading, which has to be made clear before a right conclusion can be arrived at. A private undertaking with £100,000 to the credit of its capital account may spend that sum on generating plant, and a municipal undertaking with £100,000 sanctioned for capital expenditure may do the same; at this point the position is a common one. Both undertakings are also alike in that if they are to preserve the capital invested, the price of the energy sold must include such margin as will, if reserved throughout the economic period of service of the plant, equal the original amount of money spent upon it, less any residual value. This having been done, the position is still the same in both cases, but when it comes to the application of the reserve, the difference is at once apparent. The company can dispose of it as may be decided, but the local authority must apply it in repayment of the loan debt. This, however (and it is here the confusion has arisen), makes no difference in effect, as in both cases the capital has been preserved, and thus the process known as depreciation entirely provided for.

A point to be borne in mind with local authorities is that the period sanctioned for the redemption of capital borrowings may be longer than the life of the asset, and if this happens the provision made for repayment will not properly cover depreciation. In cases where equated loans are granted a difficulty arises, as the assets with shorter lives will be out of service while the loan continues, and the assets with longer lives will be in useful service after the loan has been paid off. Equated loans have been recognised by the sanctioning authorities to be wrong in principle, and are now discontinued.

Should a case arise, however, where the loan period is too long or where obsolescence occurs (the latter factor having entered largely into the affairs of electricity supply undertakings), the necessary adjustment should be borne out of a Reserve for Contingencies, which ought always to be provided as a charge against revenue to the extent deemed necessary, being available to correct any under-provision for depreciation by liquidating any outstanding debt on plant, etc., superseded or discarded, and to meet expenditure on renewals.

The useful life of a plant is not necessarily its economic life in the undertaking first purchasing it, and when one understands the position in some undertakings and knows that superseded plant is lying idle and rendering other assets useless because the savings brought about by providing new plant exceed the extra capital charges involved, no extended argument is necessary on this point. Further, more or less heavy renewals which should be borne out of revenue occur irregularly, and a Reserve of the nature indicated would have the beneficial effect of equalising these charges, at the same time providing the means of carrying out economically necessary changes which but for the provision might not be undertaken.

Working Capital.

Working Capital could be provided by loans or from a reserve fund, and although the latter course is recommended, it is not always possible, and certainly cannot be adopted during the first few years of working. It is therefore necessary to have power to borrow for this purpose, such power to be exercisable in the absence of a reserve fund sufficient to meet the requirements. In omitting to provide this power the Legislature has passed over a vital matter, and it is difficult to understand how it could be conceived possible for undertakings to carry out their obligations under these conditions without acting ultra vires.

A certain amount of relief can be found on this question by arranging to issue monthly accounts for supply to all large consumers.

It is of more than passing interest to note the effect of a loan for working capital. The writer has calculated, from what may be assumed a typical example, that where a bank overdraft has to be obtained, costing £1,300 per annum in interest, the position could be met by a loan costing in all £2,150 per annum; but, in the one case at the end of twenty years conditions would not be improved, while in the other case the loan would be liquidated, and at a gross extra cost of £17,000 the undertaking would have accumulated a desirable reserve fund of £30,000.

Relief of Rates.

The question of relief of rates from the revenue of electricity supply undertakings has been considered by this Association before, and in an able paper read at the 1912 Convention, Mr. S. L. Pearce, the City Electrical Engineer of Manchester, refuted the majority of the arguments in favour of such a practice, suggesting that such relief might be limited to the extent of the difference between the rates of interest on similar private and public loans.

Any local rate relief, either direct or indirect, and *per contra* any aid from local rates, may be regarded as unsound and actively against the real interests of both trading and non-trading departments of the same Corporation. The modern tendency in Special Orders is towards the abolition of provisions enabling rate aid or relief to be given or received.

The strongest argument for rate relief is that moneys are borrowed on the guarantee of the rates, and therefore the funds liable should be rewarded for the risks taken. This point would seem to have been given undue importance, as the risk incurred by the general body of ratepayers nowadays in guaranteeing loans for electricity supply undertakings is a small one, and the probability that any loss will be occasioned by such guarantee is remote. If it were not generally believed that the undertakings would be self supporting the money would in the majority of cases not be called for: if the risk involved were a real one it would make itself felt in no uncertain manner.

An up-to-date and progressive electricity undertaking is a very valuable asset to any town, by reason of the benefits obtainable by the manufacturing, business and residential classes, and it cannot be too strongly urged that rate relief must retard development. Such an undertaking is created to serve the public directly, and to use it as a means of indirect taxation is to depart from the prime reason for its establishment.

Limitation of Profits.

The provision included for limiting the surplus in any year to five per cent. of the aggregate capital expenditure deserves attention, especially having regard to what will be said later on the subject of statutory forms of account. The basis adopted seems to have little to recommend it, excepting that it is very simple, and the question is exceedingly awkward when approached from the point of view of capital. The aggregate capital expenditure has no certain relation to the outstanding debt or the present value of an undertaking: capital outstanding, if taken, would not necessarily be more satisfactory, as loans may have been reduced to a very low figure, or even paid off altogether. Having regard to these points, a better basis would be:—

(47) The aggregate Capital Expenditure less the value of plant, etc., superseded and discarded,

or

(48) The total revenue;

and in view of the probable unreliability of any figure produced to represent item 47, the total revenue is thought to be the best basis. With the slow turnover in electricity supply the maximum rate of surplus would have to be higher than five per cent: fifteen per cent. is suggested as being reasonable to meet the requirements at the present time, but taking pre-war figures this percentage would have to be increased, probably to twenty per cent.

SECTION 5.—Records; of both Capital and Revenue and the Statutory Form of Accounts.

Costing.

One of the most valuable features in any scheme of control is the provision of an efficient and reliable costing system, and the writer had hoped to develop this subject in the present paper; space, however, forbids more than a few remarks on the question.

Until quite recent years the accounting systems in general use were framed to deal with businesses as a whole, the ultimate financial result was shown, but the reasons why that result had arisen was not clearly indicated.

Thus their sphere of usefulness was strictly limited and they were deficient to the extent that information of vital importance to the management was not directly available. Internal costs were almost always compiled on estimates, a main reliance being placed upon the local knowledge or experience of certain of the staff.

Modern conditions bring out in no uncertain fashion the inadequacy of these methods, as the benefits derived by concerns that have invested in scientific costing machinery prove. No method of disjointed and independent memoranda will prove of very material assistance in the long run, and in constructing a system it should be made to link in with the financial books so that all figures proceed from the very last sub-division up through each intermediate stage and division cumulatively to the grand total of expenses. A poor costing system is worse than useless. It might actually mislead and result in the pursuance of an unsound policy and so bring about direct losses of no mean magnitude.

To provide fully for costing requirements technical knowledge of the business is necessary, so that all the factors involved may be taken into proper consideration in their relative importance. This is particularly evident in regard to electricity supply. To distinguish between the real meaning of the word "Costing" and the meaning generally implied as involving merely the careful keeping of records under various headings, the writer uses the term "Expense Allocation" in connection with the system devised to secure the collection of data under appropriate headings, and the term "Costing" in connection with the utilisation of the information obtained in a technical manner to secure an accurate and correct insight into the position of affairs from time to time.

Costing systems in electricity supply serve three purposes:—

(49) To keep a check upon the expenditure under the various headings by enabling a true comparison to be obtained month by month, quarter by quarter, etc., in each of the sections and sub-sections of an undertaking.

(50) To provide sufficient data in proper form to enable the costs of supply to any class of consumers or individual large consumers to be approximated; this being necessary in constructing tariffs, in quoting for special supplies, and in watching the effect of the scales offered to different classes of consumers upon the business as a whole.

(51) To give the detailed particulars and information necessary in preparing estimates of extensions and other work; and in preparing estimates of the trading results of future periods, etc.

To ascertain costs it is necessary accurately to measure quantities and time, and for this purpose, in addition to the usual apparatus for checking workmen's attendance and other up-to-date devices for measuring stores, etc., suitable and sufficient instruments must be installed on the water, steam and electrical systems; otherwise a precise knowledge of the expense entailed in each and all of the various stages cannot be obtained, and it will be difficult to insist upon attention to items that may be unsatisfactory.

It is particularly important, if the greatest advantage is to be obtained from costing systems and returns prepared therefrom, that the figures be available immediately after the periods to which they relate have ended. A quick appreciation of the position is very necessary to enable any changes desirable to be made, so that any benefits therefrom may be realised without delay; and although all records may be most carefully kept and balanced, their usefulness is to an extent impaired if they are not available quickly.

Statistical Records.

All costs and figures should be finally summarised at least monthly in a comprehensive return based on the statutory accounts, and these figures assembled into quarterly, half-yearly and yearly statements that agree with the published accounts. A form designed on the lines suggested is reproduced on Sheet No. 1 annexed, which indicates the nature of the statement required. All figures should be kept in graphic form also.

There are statistics which will prove instructive in addition to the usual records, and a yearly analysis showing the following will be found very useful:—

(52) Percentage to Capital Expenditure and Capital Outstanding of each item under the various headings in the Capital Account.

(53) Capital Expenditure and Capital Outstanding under the headings Generation, Transmission, Conversion and Distribution per Kw. of peak load and per consumer.

(54) Percentage to total Revenue Expenditure of the main items under each of the sections of cost.

(55) Total Revenue Expenditure on the main items under each section of cost per Kw. of peak load and per consumer.

(56) Units sold and revenue per Kw. of peak load, per consumer, per £ of Capital Expenditure, and per £ of Capital Outstanding.

(57) Percentage to total revenue of sales to each class of consumer, number of consumers in each class, and average revenue per consumer.

(58) Percentage to total units sold of units sold to each class of consumer, and average units sold per consumer.

Capital Expenditure Costs.

The provision of close and continuous records of capital expenditure against loan sanctions, to ensure complete and accurate information in accounting for moneys borrowed, and to avoid over-expenditure, is a matter which seems to have proved troublesome in some cases where large and varied extensions are carried out.

All capital costs and records should be kept distinct and apart from the revenue costs, and each individual job or item must be dealt with separately in detail on the basis of the estimated cost at the time of approval of the work, modifications during progress, and the actual cost on completion.

To obtain a grasp of the position and a regular check on all items, monthly summaries should be extracted from the contract ledgers, cost books and estimate sheets, etc., in the form given on Sheet No. 2 annexed. Two summaries are shown and both are necessary; one to ascertain the commitments against sanctions, and the other to give the actual expenditure. The difference from time to time will represent the outstanding liabilities under each heading and sanction.

Financial Control.

The particular technicalities and commercial interests of an electricity supply department create requirements that are very different from the general run of Municipal Departments. The intricate problems arising are not always appreciated, and only too often such a department is classed with, and treated in the same way as, minor departments, with ill-effects and losses all round.

Electricity supply is a highly specialised business, and this should be realised, and the undertakings dealt with accordingly if the best results are to be obtained. Many of the problems can be approached from a financial or an engineering standpoint, but these two sides cannot properly and with any hope of success be entirely separated. They are inter-dependent and both contribute knowledge and experience essential to a well-balanced and far-seeing policy. It is quite a possible explanation in some cases of failure, or lack of success and progress (whichever way it may be put), that one of these points of view has predominated.

On general principles the broad scheme of control put forward by the Departmental Committee on the Accounts of Local Authorities, whose Report was issued in 1907, is a sound one. and briefly amounts to this : that the Engineering Department should be responsible for the policy adopted ; for purchasing, the certification of all expenditure, and records in connection therewith ; for sales, the certification of all revenue receivable, and records in connection therewith ; the Finance Department to deal with the actual handling of cash and to be responsible for raising capital moneys, records in connection therewith, etc. Quite workable and successful arrangements can be made on these lines, and though it is considered necessary by some engineers to have full control of the whole range of the financial operations, this view appears to be open to question. It is absolutely essential to success that up to a point everything should be under the same management, and experience proves this point to be where money is handled. An undertaking will be very seriously hampered and placed in an almost impossible commercial position, unless it is self-contained right up to and including the issue of all accounts, etc., but the actual receiving and paying of money, raising of loans, etc., if properly carried out, are matters of little interest to the Engineering Department.

Statutory Form of Accounts.

A form of accounts has been prescribed by the Board of Trade, under Section 9 of the Electric Lighting Act, 1882, for Electricity Supply Undertakings owned by Local Authorities, and this, with very little modification, has been in use and proved of great value up to the present time. The step was taken to provide for the submission of reliable figures and with a view to standardisation ; while a great deal has been accomplished, there are several matters the treatment of which might be improved.

The drafting of the statutory form is of great importance, as it will most probably fix the costing systems in use and decide to a great extent the information generally available as to results achieved in the industry.

Capital Account.

The method prescribed for dealing with the capital account and preparation of the balance sheet consists of what is known as the Double Account System, which differs from the ordinary mercantile system in that a strict line of demarkation is drawn between fixed and floating assets. This system was framed with a view to tracing easily the proper application of capital borrowings. The figures of capital expenditure are doubtless useful records under the various heads, while depreciation can be shown by means of a depreciation fund, repayment of loans, sinking funds, and other such items, but the position for all that is not quite satisfactory. If the system be strictly adhered to, the fixed assets are shown at their original cost, no steps being taken to write the amounts down by any sum representing the lessened value due to depreciation, obsolescence, etc.; the total capital expenditure from time to time is only altered by extensions and will increase as time goes on, representing at any point simply the aggregate since the inception of the undertaking.

The absence of definite provisions on these points has created a diversity of methods in dealing with questions that arise. To retain the benefits of the Double Account System depreciation, etc., cannot be shown in the usual way, as this would entirely defeat the main object, but it seems possible to extend the system so as to provide the more detailed records necessary. The writer submits on Sheet No. 3 annexed the draft of a capital account which, it is suggested, would be an improvement upon the present form in—

(59) Re-arranging and extending the heads of expenditure;

(60) Showing the effect under each of the headings of repayments and the abandonment of plant and other property discarded, etc.

It will be noted that much additional information is given which would be of use in obtaining figures for the purpose of costs and allocation of expense, or in determining the position of any group of assets. No difficulty should be met with in giving the extra particulars, as these could easily be made to form part of the loan statistical records of a Finance Department.

Statement of Loans Authorised.

The general financial position in regard to capital moneys borrowed can be brought out satisfactorily in the Statement of Loans Authorised. The form prescribed for this covers :—

(61) Amounts sanctioned;

(62) Amounts borrowed;

(63) Amounts repaid;

(64) Amounts sanctioned but not borrowed;

and it seems that these heads could with advantage be extended on the following lines :—

(65) Date of sanction;
(66) Amount of sanction;
(67) Repayment period in years;
(68) Amount borrowed;
(69) Rate of interest;
(70) Date of first redemption provision;
(71) Gross interest paid during year;
(72) Amounts added to Sinking Fund during year;
(73) Amounts redeemed during year;
(74) Amount of principal extinguished to date;
(75) Total amount in Sinking Funds at date;
(76) Balance outstanding.

Revenue Account.

The revenue account prescribed does not enable the true trading results of the supply of electrical energy to be obtained unless compensation, necessary in degree depending upon the variety and extent of other activities of the undertaking, be made. This result should be clearly shown, and where additional powers are held the surplus or deficiency of each branch of trading ought to be brought out. A system that provides for all sections of an undertaking being merged in one common revenue account does not secure that clear and definite information which is so necessary to the proper and efficient conduct of a business.

It is considered that there should be three separate revenue accounts to bring out satisfactorily the position of affairs as regards :—

(77) Supply of electrical energy;

(78) Street lighting work, apart from supply of energy;

(79) Sales, with the following subsidiary accounts:—
  (a) Sale of apparatus, etc., and installation work;
  (b) Hire of motors, radiators, and other apparatus;
  (c) Hire-purchase transactions;

although these might require extension or modification to suit any particular case. The balances of each revenue account should be taken to the nett revenue account.

It is doubtful if the heads of expenditure on the debit or expense side of the prescribed form of revenue account are sufficiently clear without an explanation of what they are intended to cover, and they are interpreted differently in different undertakings. English methods of accounting are generally very sound so far as the principles adopted are concerned, but they are often deficient in the detail required when reliable and comparable records are to be obtained. Explanatory notes should be issued with all account forms setting out in detail the items to be included under each head.

Alterations in the expense headings seem necessary to enable present conditions to be properly presented, and Sheet No 4 annexed is put forward as a suggestion.

The items on the credit or income side of the prescribed form are also capable of improvement, and the suggestions put forward for amendment are shown on Sheet No. 5 annexed.

Statement of Electrical Energy Generated, Etc.

The items contained in this statement do not bring out certain facts which are important, and require amendment to bring them up to date and to provide figures having a bearing upon the results in any undertaking. Sheet No. 6 annexed contains suggestions for headings which it is submitted would give more helpful information.

SECTION 6.—Distribution of Supply.

The cost of distribution is a vital point in electricity supply. The market for electrical energy is the consumers' terminals —a market only acquired slowly and expensively, and though production can be increased enormously at low cost, the means of distributing electrical energy will probably present obstacles to its economical marketing for some time to come. A cheap and abundant supply, in the sense that this phrase must be understood generally, is not possible merely by the erection of wonderful super-stations—a plentiful amount of copper in the streets is required also. The supply may then certainly be abundant; whether or not it will be cheap remains to be seen.

Mains extensions are directly covered in the 1899 Act by the following clauses :—

Section 21 :

> In addition to compulsory mains, undertakers to lay down *within six months* suitable and sufficient distributing mains for general supply throughout every other street or part of street in the area *if requisitioned*

under

Section 24 :

> which provides that *six or more* owners or occupiers in the street affected may make a requisition for supply;

and

Section 25 :

> which allows the undertakers to require a *guarantee of a minimum return* covering three years at the least amounting to 20% per annum upon the expenditure necessary;

but were such provisions strictly adhered to or enforced the undertakers concerned would be the first to feel the effect of such a narrow policy. If it is to be anything at all, the electricity supply business must be progressive, because as a lighting, power and heating agent it came late in the day, when gas and other interests were more or less firmly established.

Various considerations, technical and otherwise, enter into the question of mains extensions. Broadly speaking, they may be divided into three classes:—

(80) Those necessary to meet the specific new demands;

(81) Those required to open up new parts of an area in an endeavour to extend supply operations;

(82) Those required to provide for portions of a pre-arranged scheme of distribution or supplement the current carrying capacity of existing mains as rendered necessary by a general increase in load connected to the network from time to time.

Diagram No. 8 shows the financial charges (interest and redemption) per unit incurred on account of mains extensions by an expenditure of £100, with sales of from 1,000 to 10,000 units per annum. This curve is useful in the consideration of extensions under item No. 80 above. By means of three points on the curve the financial charges are shown in cases where a guaranteed minimum revenue of 20% per annum has been secured with:—

An ordinary lighting consumer, with an average price of 6d. per unit.

A mixed domestic consumer, with an average price of 3d. per unit.

A power consumer, with an average price of 1½d. per unit.

The total amount per unit available to meet all other costs, after paying the special expenses, is shown in each of these cases.

A difficulty often met with is the reluctance to understand the need for constant expenditure on mains. It is extraordinary that the average business man, who accepts the commercial principle of paying interest out of capital in the case of new concerns during the first year or few years until established, thus admitting that an adequate return cannot be

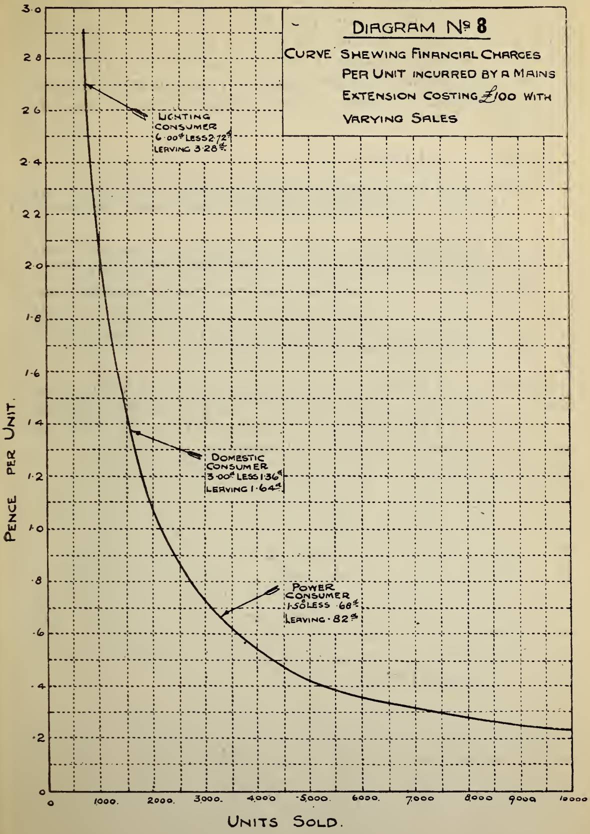

DIAGRAM Nº 8

CURVE SHEWING FINANCIAL CHARGES PER UNIT INCURRED BY A MAINS EXTENSION COSTING £100 WITH VARYING SALES expected immediately, should so often criticise proposed mains extensions on the ground that they will not secure enough revenue at once. A liberal policy is absolutely necessary in regard to mains extensions if an undertaking is to expand. No industry can be run without some risk, and no trade is possible unless provision is made in anticipation of, or to stimulate, demand.

It may be said that:—

(83) Demand follows supply, and therefore, to create the fullest and most remunerative demand, supply must be generally available.

(84) A wide demand having diverse incidence can generally only be obtained by serving a district throughout, and not in part.

(85) High load factor can often best be secured by obtaining demand for varied uses involving supply at different hours of the day.

(86) Increasing the number of consumers increases the output and generally improves the demand and load.

Omitting the question of improvement in the load factor of existing consumers, an electricity supply undertaking may be likened to a manufacturing concern situate in an isolated part of the country away from all railways and canals, etc., and dependent upon its own system of transport to convey its goods to the market. In such a case the number and capacity of the firm's vehicles would have a predominating influence, and if these could not cope with the deliveries required, then the output would be restricted, customers would be lost, and the business would generally suffer. It is recognised that the analogy is not complete owing to the difference in the relative expenditure required on vehicles and mains, but the mains serve precisely the same function in one case as the vehicles do in the other, and are for the purpose of getting the commodity to market just as essential.

Delivery is a factor that cannot be overlooked, as a wise and far-seeing policy in extending mains or providing reasonably large conductors in the first instance may result, by making the supply available quickly, in business otherwise impossible to secure. The writer has had experience in several cases where on the one hand consumers were lost because existing mains were not large enough to permit of the connection and the firms would not wait while extensions were laid, and on the other hand where valuable customers were secured because the mains were available for immediate service to the extent required.

Another phase of this important question is brought out by the following clauses of part B of the Board of Trade Regulations :—

Clause 3:

> Before commencing supply to any consumer, undertakers must declare pressure, and thereafter constantly maintain such pressure subject to a variation limit of 4%.

Clause 4:

> Before commencing supply to any consumer, undertakers to declare system, which shall be maintained and not altered except by consent of Board of Trade.

Clause 3 is certainly essential to compel a satisfactory supply, but it may cause a certain amount of anxiety to the engineer responsible, and will sooner or later be in evidence in cases of extensions mentioned under item 82 above. In the writer's experience some very awkward situations have been created under Clause 4.

Practically the whole of the medium and large sized undertakings generate alternating current at extra high pressure, and where this has to be converted to direct current to serve the older parts of the distribution system, considerable expense is entailed by reason of the capital charges on the converting plant and its foundations, housing, etc., and the losses in conversion. The cost of converting plant to-day is in the order of £6 per kilowatt, a very heavy item in view of the fact that before the war complete generating stations were projected at a total cost of about £10 per kilowatt. In a number of areas the question of changing over from D.C. to A.C. distribution is becoming an important problem, and it is difficult to find the best solution. A wholesale change over, even of portions of a system, is impossible without long and careful preparation, but in certain cases valuable work is being done by carrying out all mains extensions with four-core paper lead cables and arranging services accordingly (although operating these in the meantime with D.C.), thus gradually building up the skeleton of an A.C. network to utilise when the most opportune time arrives. In this way, too, the expenditure necessary is met gradually—a valuable help.

SECTION 7.—Sales and Commercial Development.

Careful attention to economies in generation and distribution is very necessary, but there is a danger in the absorbing attraction of engineering detail, and this would seem to have been given an unduly large proportion of the management's attention in the past: more surprising effects can often be produced on the financial results by a live and progressive Sales Department that is successful in extending the use of supply and increasing output. Sales development in electricity supply has been slow up to recent years, although its importance is now being more and more recognised.

It is somewhat difficult to single out the most important factor in development, as several items so combine to make for the best results, that any one cannot be said to be of the greatest help without the others. The personal element is undoubtedly a first consideration and a vital matter. Success demands ability to deal with any requirements, however large and complex, unfailing courtesy in face of all conditions, and obliging attention to all questions, however trivial some of them may seem; in fact, a professional tone must prevail, and to illustrate what is in mind the following extract from a recent speech by Sir John Simon is absolutely to the point:—

> "A profession is a pursuit which is followed not solely as a livelihood, but always subject to over-riding duties prescribed by a code of professional honour, involving in an especial degree the strict observance of confidences in which the work that we do must be rendered to our clients without stint in proportion to our clients' need rather than in proportion to the reward which we receive."

Without this atmosphere all efforts in the direction of a good supply, fine showrooms, plenty of advertising, a thorough system, etc., etc., will not achieve the fullest results. Consumers must be impressed with the modern commercial outlook and efficiency of the Department and *all* its staff and employees; they must be made to feel the entire absence of a cold and unsympathetic officialdom, and all transactions and relations should be cordial and satisfying.

Then, the following may be regarded as essential:—

(87) The commodity supplied must be satisfactory in use;

(88) The price must meet competition;

(89) The attention given to all enquiries must without exception be full and prompt;

(90) There must be ample facilities for exhibition and demonstration of apparatus;

(91) There must be interesting and constant advertising.

The first service is to present consumers, as a satisfied and contented consumer is one of the best advertisements that can possibly be obtained, while a discontented one is the worst form of difficulty to meet with—an acknowledged failure.

A first-class showroom in a good central position, equipped with complete demonstrating rooms, and having in stock all types of the latest appliances for the various services, is of very material assistance. It is a mistake to rely on catalogue illustrations to show what might be done; the effect of having apparatus available for actual demonstration is of noticeable benefit. Of course, there are special cases which it is impossible to meet from a stock, however large and varied, but these should not frequently occur. The showroom must be attractive and of a high class appearance, tastefully decorated and set out, and be particularly clean and well kept. Advantage can be obtained by studying the methods adopted in up-to-date retail shops and stores in other trades. Window displays should be varied as much as possible; it is a good thing to specialise, devoting a day to a particular branch of service in its various ramifications. The window level can be well arranged low down, and so that a view of the whole of the main shop is open from the street. All showroom attendants and demonstrators should be smart, alert, and of good personal appearance.

Advertising is of great value. To be most effective it must be sustained, being carried out locally and on a national scale. The industry is particularly fortunate in having the Electrical Development Association now, and provided the greatest possible use is made of this Association the help so obtainable should prove invaluable. It is only on co-operative lines that electricity supply undertakings can afford the well-written and illustrated publicity matter required and maintain the general advertising, as distinct from local individual efforts, that creates such an impression on the public.

Everyone engaged in selling a commodity should believe it to be the best on the market for its purpose, and thus be able genuinely to put forward its merits to the best advantage. This cannot be done unless personal experience has been gained, and in the writer's opinion all members of the staff of an undertaking, from the Chief Engineer downwards, should be required to use electricity for service in their homes. There is nothing like a practical belief in one's wares to carry conviction.

The retail or selling side of electricity supply has been more or less left to look after itself in a number of cases, and probably this has been due to the conditions obtaining. The problems to be met cannot quite reasonably be compared with those arising in selling, say, personal apparel, as the factors are so different. Electricity is a service (as distinct from goods) that is permanently required; it does not wear out and is not cast aside after a few months; it must give continuous satisfaction. An electricity undertaking's consumers are always with it, and the satisfaction in use depends upon a number of things. Selling electricity means selling lighting, power, heating, cooking, etc., and the consumer's point of view has to be understood. Service is the object, and though the supply itself may be perfect, the sales results are liable to be disappointing if consumers do not obtain a reliable and economical means of achieving their ends. To ensure this the most suitable appliances must be installed, *their use fully understood*, and prompt help must always be available to deal with failures and defects. Stress is laid on the importance of a maintenance section; all complaints and faults in apparatus should be dealt with immediately. The value of this can hardly be exaggerated, as satisfaction cannot be entirely measured by a good supply, and if apparatus in use does not fulfil requirements, very often prejudice is created against electrical methods. Consumers somewhat naturally look to the supply undertaking as the source of either the benefits or worries resulting, and, indeed, the interests of the consumer and the undertaking are so tied together that it is a little difficult to see how great progress can be made unless powers are given to sell and hire-purchase the various lighting, power, heating, cooking, etc., appliances and to carry out repair and maintenance work. The general absence of these powers has no doubt exercised a deadening effect, and has certainly placed the industry at a disadvantage compared with the gas industry, in which such restrictions have not been thought necessary. Relief has been given in this direction under Section 23 of the 1919 Act in granting hiring powers, and the position would be very much helped if these could be extended at least to hire-purchase.

Hire and hire-purchase are an essential part of any scheme of development owing to the cost of installations and apparatus, and unless cultivated it would appear that the domestic uses of electricity (in all but the higher class of residence) must be very much restricted for some time to come. Such schemes necessarily require the command of working capital, and this is one of the directions in which an adequate reserve fund would be of help. Continued experiments are necessary to determine the best type and rating of apparatus for various uses, and this can only be done if money is available for the purpose. As a general rule, private trading does not cater for operations on these lines, and thus one of the most helpful branches is entirely unprovided for.

One of the most important questions in administering a Sales Department is to work on co-operative lines with the local wiring contractors. Every effort should be made to secure a mutually satisfactory arrangement, as up to a point the interests are to be regarded as identical. Both parties can be of great assistance to each other, and the writer considers that the unfortunate position—almost amounting to antagonism—in some towns is entirely due to a want of appreciation of the dependence of each branch of the industry on other branches. At the same time, both parties have to exhibit a desire to be reasonable and help the mutual interests, or the best of endeavours on one side will not secure success. A live and pushing policy will benefit the wiring contractors, while it helps to develop supply. It must follow that the greater the expansion in any area the greater are the chances for the wiring contractor. The function of a Sales Department is emphatically not to cut out or restrict the activities of wiring contractors, and benefits would ensue to both parties by a better understanding and a regular interchange of views upon the various questions arising.

Generally it may be said that an undertaking should not tender against the wiring contractors so long as sound work is carried out and a combination is not formed to raise or maintain prices. Consumers appreciate the help that is given by advice as to their installations, by the preparation of specifications designed to secure good class work and comparable tenders, by inspection of work during progress, and in other ways. Arrangements on these lines in connection with the bulk of the new wiring installations should be of real benefit to everyone concerned.

Undoubtedly the greatest field for development in the future is in domestic supplies, as will be realised when consideration is given to the number of consumers any Undertaking has connected compared with the number of dwellings in its area of supply. In the majority of cases it only amounts to 10%, and in many cases it is even less. Progress will naturally be gradual, but the domestic demands in many cases are assuming large proportions. A great deal can be achieved by endeavouring to secure that all new houses are wired and equipped for electricity supply.

A town of, say, 200,000 inhabitants will have about 40,000 dwellings, and the immense possibilities are evident by analysing the potential load in these. Assuming only half this number electrified, and an average demand of but one kilowatt per house, surely a reasonable assumption, the resultant demand is 20,000 kilowatts!

It has been said "Educate your public." That is quite right; it is very necessary, but the writer would add "and educate them while young." The future generation of housewives is passing through its school days at present, and with the inclusion of domestic economy in the curriculum if electrical methods could be introduced into school demonstrating classes this would be of help in enabling students to become accustomed to the uses of electricity and to realise the many advantages to be obtained, in the lightening of domestic labour, in better conditions, in superior cooking, in greater cheerfulness, and general all round economy.

Electric vehicle progress is an excellent illustration of the enterprising manner in which Municipalities have helped to foster the growth of a new form of demand, and many undertakings are to be congratulated upon their cultivation of this ground. Provisions have been made in a few instances that can properly be regarded as a model of the way in which a new line of business should be tackled, although it is true steam-driven wagons are used in some undertakings despite the repeated proofs brought forward of the savings that can be made by the adoption of electric vehicles. There is a big future for the electrically-propelled vehicle, and the following figures (covering a recent period of six months), giving the total costs of running two 3½ tonners, may be of interest.

Item.	No. 1.	No. 2.
Age of Vehicle	3½ years.	1½ years.
Total Cost	£1,225	£920
Nett number of days in period	126	126
Hours in use to possible hours (47-hour week)	94%	93%
Kw. hours per mile	1.87	2.22
Total miles travelled	2,431	2,613
Total journeys made	783	839
Total weight carried, tons	2,210	2,472
Ton miles	6,862	7,700
Costs:—	£ s. d.	£ s. d.
Capital Charges (8 years' life)	94 19 0	71 6 0
Battery (2 years' life)	70 0 0	70 0 0
Tyres (2 years' life)	8 10 0	8 10 0
Insurance	3 10 0	3 10 0
Wages	189 11 10	101 13 5
Repairs and Maintenance	44 4 11	16 19 8
Electrical Energy, at 2¼d. per unit	42 10 10	54 10 1
	£453 6 7	£326 9 2
Cost per ton mile	1/3.85d.	10.18d.
Cost per hour in use	7/10.88d.	5/8.9d.

SECTION 8.—Legislation governing the Industry.

The check put upon progress and development by restrictive clauses in the Electric Lighting Acts has been generally deplored. There has, too, been some truth in the protests made, but on the other hand it must be remembered that the original provisions, enacted nearly forty years ago, have proved singularly competent in many directions to guide the industry throughout its rapid growth, and every undertaker is indebted to those who devoted themselves to the interests of electricity supply in framing or helping to frame sections which are very valuable—probably more valuable to-day than ever. The requirements under Section 27 of the Electric Lighting (Clauses) Act, 1899, in respect of individual use of supply (so as not to interfere with general supply) and the condition of the electric lines, fittings and apparatus to be connected to the mains; and under Section 28 of the same Act, the obligation of consumers to specify the maximum power required, are examples illustrative of the foresight displayed in some directions.

The character of the industry has completely altered in the past forty years, and when the 1882 Act appeared the present magnitude of supply operations was not conceived. Since then a further Act has been passed practically every ten years, in 1888, in 1899, in 1909, and in 1919; reasonable criticism arises from the fact that the opportunities provided by each subsequent enactment do not appear to have been taken to amend certain clauses which are obsolete and which under the altered conditions do not secure the effects desired.

The parochial nature of the powers granted to undertakers is the most serious point of general importance to be raised, and is a well worn subject, but the restrictions entailed may, in fact, turn out to be blessings in disguise. It is a matter of interest to conjecture in what position the industry would have found itself at the present time if undertakers had always been able to extend and branch out all over the country with systems that have since proved uneconomical and unsuited to large extensions and wide development. Conditions are now more stable, as experience has been gained in the running of large plants and in distribution over wide areas with different systems, and a point has been reached when an increase in overall efficiency seems very limited; thus the present is a time when the possibilities opened up by the treatment of supply operations in large districts can be utilised to great advantage.

It would be a great help to development and a progressive step if general arrangements could be made to widen the supply areas of undertakers by enabling them to deal with surrounding districts which could be economically served from existing stations without the need for creating new undertakers. A large number of "fringe" Orders have been granted under Section 6 of the 1909 Act, which have been very useful, but these are restricted to specific consumers, and there is a need for expansion on the lines suggested.

Section 8 of the 1909 Act, under which authority may be given to joint exercise of powers by undertakers, has not been as fruitful as might have been expected, and, indeed, general interest in the many economies that were possible by its application has only been aroused under the stringent conditions brought about by the late war. The outstanding example of a successful scheme on these lines is the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board, whose consistent low costs of production are always conspicuous in published tables showing the yearly results in the industry.

Unfortunately, up to the present time the industry has been starved—starved by lack of cheap capital, starved by its small revenues, and starved by the absence of large conceptions of enterprise. It is hoped that the Act of 1919 is an earnest of the opening up of a new chapter. The personnel engaged in electricity supply abounds in energy and initiative, and it is anticipated that when the restrictions hitherto imposed are removed, a great improvement and generally more satisfactory condition will result.

The public importance of electricity is now very generally recognised, and there is an insistent demand for a more effective and economical utilisation of the resources of nature for general service by means of this agent. The past few years have brought out vividly, and in a way which but for the late

European War would seem to have been impossible, its unrivalled power and influence from a health and labour-saving point of view. The public are showing an active desire to be served in the best manner for both business and domestic needs, and are no longer content to carry out operations necessitating waste of time and in many cases even drudgery if older means are employed, when they can be materially helped by the up-to-date applications of electricity. It is accepted that electricity has become a necessity in a modern civilised community, and it would appear to be only a matter of relatively short time before the demand becomes so varied and intense as to surpass all previous calculations. Whoever was responsible for the insertion of Section 29 in the Electric Lighting Act, 1882, which provides for the relief of gas undertakers' obligations in areas sufficiently served with electricity, and thereby rendered unremunerative, is to be congratulated upon his foresight and ability to anticipate the position that is now coming about. In most districts the demand is being held in check and progress considerably impeded by the fact that Undertakings are not able to meet the load waiting for connection at present.

The liability of undertakers under Section 17 of the 1882 Act to make compensation for damage, and under Section 81 of the 1899 Act to proceedings for nuisance, prove irksome when the powers granted have been exercised in a reasonable and careful manner, and some amendment of these provisions on the lines indicated in the report of the Joint Committee on Electrical Energy, issued in 1898, is still required. The possibility of an injunction against the working of a generating station responsible for an important utility, even in the absence of negligence, is not consistent with public interests.

Damage to posts and other street works occurs with increasing frequency, causing in many cases heavy expense to undertakers—irrecoverable in the absence of proved negligence (almost invariably difficult to establish). Protection to the extent of £5 is given by Section 20 of the Gasworks (Clauses) Act, 1847, but the conditions of to-day, with greatly extended networks and an enormous increase in vehicular traffic, have outgrown this small amount, and additional protection against injury is wanted.

Order and regulation are necessary with a public utility service to secure, for instance, that consumers are fairly dealt with, and it seems the best results can only be obtained under prescribed conditions by endeavouring to interpret statutes liberally, having regard to the spirit rather than the letter of the law—whenever this is possible and allowed. It may be that while prescribing obligations and giving rights, the existing enactments have frequently made the obligations too great and the rights too small, but it is admittedly easier to see after the event, and the comments made in the course of this paper are submitted in a desire to direct attention to some of the provisions which might be improved to the benefit of all concerned.

Thanks are tendered to Mr. S. T. Allen, Chief Engineer, Wolverhampton, for facilities provided in the preparation of this paper, and to Mr. C. H. Yeaman, Chief Engineer, Stoke-on-Trent, for a large amount of information placed at the writer's disposal.

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ELECTRICAL ENGINEER'S DEPARTMENT.

STATISTICAL RETURN AND COST SHEET FOR THE OF 19 .

Sheet No. 1.

RECORDS	LAST YEAR		THIS YEAR	
OUTPUT, ETC.	Units	% to Total Supply	Units	% to Total Supply
1 Units Sold				
2 Units used in Undertaking:-				
a For Lighting Heating, etc.				
b For Auxiliaries				
3 Losses:-				
a Batteries				
b Conversion				
c Transmission and Distribution.				
Total Supply				
4. Units Generated:-				
a By Coal and Coke.				
b. By				
c. Bulk Supplies received.				
Total Supply				
5. Capacity of Generating Plant. Kw				
6. Peak Load.	Date	Kw.	Date	Kw.
7. Load Factor and Utility Factor.	L.F.	U.F.	L.F.	U.F.
FUEL, ETC.				
8 Cost per Ton.-				
a of Coal and Slack delivered.				
b of Bunkering.				
c. of Ash Removal.				
Total Average Cost per Ton.				
	Tons	Per Unit Generated	Tons	Per Unit Generated
9. Fuel Consumed:-				
a Coal				
b Coke				
Total				
10 Average Calorific Value of Fuel used. B.Th.U.	Coal Coke	Total	Coal Coke	Total
11 Ash made.	Tons	% to Fuel used	Tons	% to Fuel used
12 B.Th.U. per Unit generated.				
13 Lbs. of water evaporated				
14 " " " " per lb. coal used.				
15 " " " " " unit generated				

CONSUMERS, ETC.	No. of Consumers	Kw.	N.P. of Motors	No. of Consumers	Kw.	H.P. of Motors
16 Connections to mains during period:—						
a Lighting			–			–
b Heating and Cooking						–
c Power and Industrial						
d Traction						
e Bulk Supplies						
f Street Lighting.			–			–
Total						

	No. of Consumers	Kw.	No. of Consumers	Kw.
17 Total connections at end of period:—				
a Lighting				
b Heating and Cooking				
c. Power and Industrial.				
d. Traction				
e Bulk Supplies				
f Street Lighting.				
Total				
18 Motors connected at end of period	H.P.	No.	H.P.	No.

MAINS, ETC.	LAST YEAR	THIS YEAR
19. Miles laid at end of period:-		
a Transmission Lines		
b Feeders		
c Distributors		
20 No. of Services.		

COSTS OF PRODUCTION	LAST YEAR				THIS YEAR			
	Direct Wages £ s. d.	Materials, etc. £ s. d.	Total £ s. d.	Average per Unit Sold d.	Direct Wages £ s. d.	Materials, etc. £ s. d.	Total £ s. d.	Average per Unit Sold d.
A. GENERATION EXPENSES.								
1. Coal and other fuel, including transport and handling of same, and ash removal.								
2 Oil, waste, water and engine room stores.								
3 Salaries, and shift and running wages.								
4. Repairs and maintenance of buildings, yards, roadways, etc.								
5. Repairs and maintenance of station wiring installations and lighting.								
6. Repairs and maintenance of steam plant, boilers, turbines, etc.								
7. Repairs and maintenance of electrical plant, generators, exciters, etc.								
8. Repairs and maintenance of auxiliary plant.								
9. Repairs and maintenance of switchgear, instruments, and tools.								
10. Repairs and maintenance of accumulators and accessories.								
11. Rents payable.								
12. Local Rates.								
13. Insurances.								
14. Capital Charges.								
Sub-Total								
B. BULK SUPPLIES RECEIVED.								
1 Electrical Energy purchased								
2. Transmission expenses.								
3. Capital Charges.								
Sub-Total								
C. TRANSMISSION.								
1. Salaries, and wages of inspectors, linesmen, etc.								
2. Repairs and maintenance of buildings, yards, roadways, etc.								
3. Repairs and maintenance of transmission section wiring installations and lighting.								
4. Repairs and maintenance of overhead lines.								
5. Repairs and maintenance of underground mains								
6. Repairs and maintenance of transformers.								
7. Repairs and maintenance of switchgear, instruments, and tools.								
8. Rents and wayleaves payable.								
9. Local Rates.								
10. Insurances.								
11. Capital Charges								
Sub-Total								
D. CONVERSION EXPENSES.								
1. Salaries, and shift and running wages.								
2. Repairs and maintenance of buildings, yards, roadways, etc.								
3. Repairs and maintenance of conversion section wiring installations and lighting.								
4. Repairs and maintenance of converting plant, etc.								
5. Repairs and maintenance of switchgear, instruments, and tools.								
6. Rents payable.								
7. Local Rates.								
8. Insurances.								
9. Capital Charges.								
Sub-Total								
E. DISTRIBUTION EXPENSES.								
1. Salaries, and wages of meter readers, storkeepers, timekeepers, etc.								
2. Repairs and maintenance of buildings, yards, roadways, etc.								
3. Repairs and maintenance of distribution section wiring installations and lighting								
4. Repairs and maintenance of machinery.								
5. Repairs and maintenance of switchgear, instruments, and tools.								
6. Repairs and maintenance of transformers								
7. Repairs and maintenance of mains								
8 Repairs and maintenance of service lines.								
9. Repairs and maintenance of switches, cutouts, and other apparatus on consumers' premises								
10. Repairs and maintenance of meters, indicators, etc.								
11. Rents and wayleaves payable								
12. Local Rates								
13. Insurances								
14. Capital Charges.								
Sub-Total								
F. MANAGEMENT EXPENSES.								
1. Salaries.								
2. Printing and stationery								
3. Legal costs								
4. General establishment charges.								
5. Local Rates								
6. Other Taxes and imposts.								
7. Insurances								
8. Publicity and advertising.								
9. Capital Charges.								
Sub-Total..								
TOTAL COSTS								

CAPITAL ACCOUNT, LOANS EXPENDITURE SHEET.

Sheet No. 2.

For the ended 19 .

Loan Sanctioned.			Expenditure to	Expenditure during 19 .				Total Expenditure to
Date.	Amount.	Covering.		Direct Labour.	Direct Material.	Invoices and Certificates.	Total.	
			£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.

CAPITAL ACCOUNT, LOANS LIABILITY SHEET.

For the ended 19 .

Item or Job.	Loan Sanctioned.			Commitments to	Estimated Cost.			Total Commitments to
	Date.	Amount.	Covering.		Direct Work.	Contracts and Orders.	Total	
				£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.

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Sheet No. 3.

CAPITAL ACCOUNT

For the Year ended 31st March, 192 .

Dr. Cr.

Item.	Expenditure up to	Expended during the year.	Total Expenditure to	Existing Assets.				Cost of Assets Sold or Discarded.	Total.
				Loans.			Expenditure met out of Revenue and Reserve.		
				Amounts Repaid.	Redemption Funds in Hand.	Outstanding Liability.			
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
(a) **GENERATION.**									
1. Land.									
2. Buildings.									
3. Accumulators.									
4. Machinery.									
5. Switchgear and Instruments.									
6. Other Items.									
Sub-Total									
(b) **TRANSMISSION.**									
1. Land.									
2. Buildings.									
3. Overhead Mains.									
4. Underground Mains.									
5. Transformers.									
6. Switchgear and Instruments.									
7. Other Items.									
Sub-Total									
(c) **CONVERSION.**									
1. Lands.									
2. Buildings.									
3. Converting Machinery.									
4. Switchgear and Instruments.									
5. Other Items.									
Sub-Total									
(d) **DISTRIBUTION.**									
1. Lands.									
2. Buildings.									
3. Machinery.									
4. Switchgear and Instruments.									
5. Transformers.									
6. Feeding Mains, Pillars and Boxes.									
7. Distributing Mains, Pillars and Boxes.									
8. Services.									
9. Meters.									
10. Other Items.									
Sub-Total									
(e) **PUBLIC LIGHTING.**									
1. Mains.									
2. Posts, Pillars and Fittings.									
Sub-Total									
(f) **SPECIAL ITEMS.**									
1. Patents.									
2. Engineering Expenses.									
3. Legal and Financial Expenses.									
4. Other Items.									
Sub-Total									
TOTALS	£	£		£	£	£	£	£	
Balance				Balance					
			£						£

SUGGESTED EXPENSE HEADINGS FOR REVENUE ACCOUNT COVERING SUPPLY OF ELECTRICAL ENERGY.

A.—GENERATION EXPENSES.

1. Coal and other fuel, including transport and handling of same, and ash removal.
2. Oil, waste, water, and engine room stores.
3. Salaries, and shift and running wages.
4. Repairs and maintenance of buildings, yards, roadways, etc.
5. Repairs and maintenance of station wiring installations and lighting.
6. Repairs and maintenance of steam plant, boilers, turbines, etc.
7. Repairs and maintenance of electrical plant, generators, exciters, etc.
8. Repairs and maintenance of auxiliary plant.
9. Repairs and maintenance of switchgear, instruments and tools.
10. Repairs and maintenance of accumulators and accessories.
11. Rents payable.
12. Local Rates.
13. Insurances.

B.—BULK SUPPLIES RECEIVED.

1. Electrical Energy purchased.
2. Transmission Expenses.

C.—TRANSMISSION.

1. Salaries, and wages of inspectors, linesmen, etc.
2. Repairs and maintenance of buildings, yards, roadways, etc.
3. Repairs and maintenance of Transmission Section wiring installations and lighting.
4. Repairs and maintenance of overhead lines.
5. Repairs and maintenance of underground mains.
6. Repairs and maintenance of transformers.
7. Repairs and maintenance of switchgear, instruments and tools.
8. Rents and Wayleaves payable.
9. Local Rates.
10. Insurances.

D.—CONVERSION EXPENSES.

1. Salaries, and shift and running wages.
2. Repairs and maintenance of buildings, yards, roadways, etc.
3. Repairs and maintenance of Conversion Section wiring installations and lighting.
4. Repairs and maintenance of converting plant, etc.
5. Repairs and maintenance of switchgear, instruments and tools.
6. Rents payable.
7. Local Rates.
8. Insurances.

E.—DISTRIBUTION EXPENSES.

1. Salaries, and wages of meter readers, storekeepers, timekeepers, etc.
2. Repairs and maintenance of buildings, yards, roadways, etc.
3. Repairs and maintenance of Distribution Section wiring installations and lighting.
4. Repairs and maintenance of machinery.
5. Repairs and maintenance of switchgear, instruments and tools.
6. Repairs and maintenance of transformers.
7. Repairs and maintenance of mains.
8. Repairs and maintenance of service lines.
9. Repairs and maintenance of switches, cut-outs, and other apparatus on consumers' premses.
10. Repairs and maintenance of meters, indicators, etc
11. Rents and Wayleaves payable.
12. Local Rates.
13. Insurances.

F.—MANAGEMENT EXPENSES.

1. Salaries.
2. Printing and stationery.
3. Legal costs.
4. General establishment charges.
5. Local Rates.
6. Other taxes and imposts.
7. Insurances.
8. Publicity and advertising.

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Sheet No. 5.

SUGGESTED REVENUE ACCOUNT INCOME HEADINGS.

Sales of Electrical Energy:—

1. Lighting.
2. Heating and Cooking.
3. Multipart Tariffs for Business and Domestic Supplies.
4. Power and Industrial Supplies.
5. Traction.
6. Bulk Supplies.
7. Street Lighting.
8. Hire of Meters.
9. Fees for Inspection of Maps, Accounts, etc.
10. Any other items (to be specified).

Less provision for Bad Debts and items written off.

Sheet No. 6.

SUGGESTED ITEMS FOR INCLUSION IN STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

1. Units Sold:
    - (a) Lighting.
    - (b) Heating and Cooking.
    - (c) Multipart Tariffs for Business and Domestic Supplies.
    - (d) Power and Industrial Supplies.
    - (e) Traction.
    - (f) Bulk Supplies.
    - (g) Street Lighting.

Total Sold ....

2. Units used in Undertaking.
3. Units used in Transmission, Conversion and Distribution.

Total Supply ....

4. (a) Units Generated
    - by Coal and Coke
    - by ....

   (b) Bulk Supplies received.

Total Supply ....

5. Units Sold to Total Supply, %.
6. Units Used in Undertaking to Total Supply, %.
7. Fuel Consumed—

	Tons used.	Lbs. per Unit Generated.
(a) Coal		
(b) Coke		
(c)		
Total		

8. Ash made: Tons ....% to fuel used ....
9. Average calorific value of fuel as received:

   Coal .... B.Th.U. }
   Coke .... B.Th.U. } Total .... B.Th.U.

10. Number of Consumers connected to mains.
11. Total connections to mains in Kw.
12. Total H.P. of motors connected to mains.
13. Number of street lamps.
14. Capacity of generating plant installed, in Kw.
15. Maximum observed load, in Kva. .... Power Factor ....
16. Load Factor.

DISCUSSION ON MR. C. W. CHARLESWORTH'S PAPER.

Councillor D. HYND proposed a hearty vote of thanks to Mr. Charlesworth for his paper.

Alderman T. E. HIGHAM (Accrington) seconded, and expressed the hope that copies would be distributed amongst members of committees and electricity staffs, because the paper contained information for which they were all very badly in need.

The PRESIDENT remarked that it would be possible to obtain for distribution copies of the Annual Proceedings, in which the paper and discussion would appear.

Bailie W. B. SMITH (Glasgow) said that at the beginning of the paper reference was quite rightly made to the repayment of capital. This was the first year they had been working under the guidance of the Electricity Commissioners, and their experience in Glasgow had not been altogether satisfactory. Glasgow, like other undertakings, were prepared to extend their undertaking to the greatest possible extent that was necessary for the development of the cheapest possible supply of electricity, but when they asked for powers to borrow money they were immediately hampered by restrictions which he believed they would all agree were unnecessary. The paper called attention to the difference in capital expenditure required now as compared with pre-war, and it was seen that £250 was now required for every £100 pre-war, with a consequent increase of the capital charges from £7 4s. to £25 1s., and restrictions upon municipal undertakings must, in these circumstances, only hamper development. It was not right that he should criticise the President's Address, but he would like to agree with the remark made in it as to the necessity for there being the best relationship between municipalities and companies. There was, however, a distinct difference between company undertakings and municipal undertakings in the matter of repayment of capital, because the companies could repay their capital whenever they liked, but municipal electrical undertakings must repay theirs in something like 25 years to repay the whole capital. That meant that the cost of generating electricity was higher to municipalities than to companies. Similarly, compared with gas undertakings, municipal electricity undertakings were handicapped, because gas undertakings were allowed something like 40 years in which to repay all their capital. He believed, however, that they would all agree that an electricity undertaking was as lasting as a gas undertaking. Land, if well bought, would never decrease in value, and would at least remain the same; in most cases it increased in value, yet loans for land, with everything else, had to be repaid in 25 years. Buildings, if properly constructed and maintained out of revenue, as they nearly all were, were as good at the end of 60 years as when put up, and yet electricity undertakings had to repay loans on them in 25 years. In the days of the old Scottish Office they were allowed reasonable time to pay off borrowed money, but they were not told a definite number of years. That was an aspect of the paper which needed very serious consideration, because, with the increased capital charges, municipalities ought to be allowed to use their judgment a little more and not be guided by a body of Commissioners sitting in London, who said they could not make exceptions, and that all municipalities must be treated alike. He did not for a moment accept that, and believed that each undertaking ought to be dealt with on its own basis. They must each, in their own locality, be allowed to use a reasonable judgment as to how and when they repaid the loans for which they were responsible. No municipality wanted to hold back the repayment of its loans, because that was bad finance. It had not been the disposition of his own municipality to hold back repayments. When they had money they paid off the whole tramway undertaking within 25 years, and every penny of the outstanding loan had now been paid off. The result of that was that, whereas in London the L.C.C. Tramways charged a penny for six-tenths of a mile, in Glasgow a penny was charged for eleven and a half tenths of a mile, which was about one-half of the London fare. Therefore, he thought they would agree that municipalities ought to be allowed to exercise some judgment as to the period in which they repaid their loans, and that there should not be a hard and fast rule settled by Commissioners, who probably had had less experience in local authority finance than the local authorities themselves. A certain amount of elasticity must be allowed in paying off municipal capital, according to what seemed judicious to those who were responsible, in order that the charges for electricity by municipalities might more nearly compare with the charges made by companies.

Alderman W. WALKER (Manchester) said he hoped the meeting would not fall to the temptation put before it by Bailie Smith, because it was one of the most retrograde policies he had ever heard of, that municipal authorities should have the right to fix for themselves the period of loan repayment. He could well imagine what would happen if municipalities were allowed to suspend their sinking fund. Bailie Smith had a wonderful confidence in municipal government that he himself after a very long experience did not possess, and he was convinced that if municipalities had the right to suspend their sinking fund some of them would do so to-morrow, irrespective of the consequences in the future. Bailie Smith had only selected two items in the whole of the capital expenditure, namely, land and buildings, but the effect of these on the cost of electricity was infinitesimal and not worth worrying about. If Bailie Smith could have said that the period allowed for loans for turbo generators and other plant was too short, then there might have been some reason for suggesting to the Commissioners that a longer period should be given. So far, however, from that being the case, there were many municipalities to-day which, in addition to the statutory sinking fund, had a special account into which they paid any excess over the statutory amount, in order to be able to renew their plant at the first economic opportunity, i.e., before the loan for the plant itself had expired. It was unwise to suggest that the sinking fund should be postponed. If it were made possible for municipalities to suspend sinking funds, he could imagine many cases in which the loans on plant would not have been repaid when the plant itself had come to an end, so that the revenue earned by the new plant would have to be sufficient to meet a part of the capital charges of the old plant which it had replaced as well as its own. There would thus be built up an accumulation of capital charges which would bring about disaster, with the result that the whole of the Electricity Committee would find themselves fired out if not hung by indignant ratepayers.

Bailie A. KENNEDY (Convener of the Glasgow Electricity Committee) said he could assure them that no such thing was in contemplation as had been suggested by Bailie Smith. Bailie Smith had spoken without the Committee's authority and certainly did not express his opinion—(laughter)—but an endeavour had been made to get the Commissioners to give a little longer term than was usual, perhaps five years. So far as the Commissioners were concerned, he had always said that if they did not keep Mr. Lackie and Mr. Page in Scotland they would go to London and control the undertakings, and what he had feared seemed very likely to take place—(more laughter)—but he had no quarrel with the Commissioners. He believed the electrical engineers would find means for paying off loans as necessary, and if they only set aside ample depreciation funds it would enable their engineers to spend money on new plant when necessary.

Alderman J. A. G. BEAUMONT (St. Marylebone) said the Paper was an extraordinarily comprehensive presentation of the detailed working of electricity undertakings on the financial side. He was not going to comment on Alderman Walker's comments on Bailie Smith's remarks, and what the position of municipal undertakings was likely to be with regard to capital charges. At the same time, there was no question that if the temptation were given to many of them to suspend the sinking fund they would inevitably fall to it. Another subject which was allied to this was that of working capital. The Paper indicated that municipal undertakings were at a distinct disadvantage with regard to working capital, as compared with companies. Companies could always go to the public and raise a further issue of capital. Indeed, there had been three considerable issues of new capital by London companies in the last two or three months, and they had all been successful. A municipal undertaking, however, could not do that, and its borrowings were strictly limited to the special purpose for which the new capital was required. That placed many municipal undertakings in a difficult position with regard to working capital, which could only be obtained by creating a reserve commensurate to the capital involved in the business. There was, however, considerable difficulty in creating that reserve, because the reserve could only come from the surplus revenue at the end of the year. Municipal undertakings were in a difficult position with regard to creating a big revenue surplus, because, whatever the point of view of their engineers and managers might be, they were always to a certain extent hampered by the fact that the political consideration came in; he meant political in its broadest sense. There were those who held that a publicly owned undertaking was not there primarily to make profits, but to give the cheapest supply to the consumer, whilst others held that sufficient reserve should be built up out of revenue. He had found from his comparatively short experience of management that to combine these two policies was not a particularly easy thing to do. The companies, on the other hand, were not bound by any such considerations at all. Of course, companies were bound by considerations of trading prudence, just as every other industry was. They could not increase prices beyond a certain point, because if they did that business fell off. At the same time, the companies were not in the difficult position that municipalities were in regard to building up sufficient reserve to provide current working capital, and his experience at St. Marylebone had been that this was a most difficult thing to do. He was not prepared at the moment to say what was the remedy for this state of affairs, and even Mr. Charlesworth did not actually suggest a definite remedy. At the same time, he did feel that in the future working of municipal undertakings some remedy would be devised, and that they would no longer be content to go on in the unfavourable position they were in on this matter as compared with company undertakings.

Mr. S. J. WATSON (Bury) thought the Paper was welcome because it dealt with sales and development, which, unfortunately, during the past few years had been rather allowed to slide. It now, however, behoved us again to look into the question of the active development of the work. The provision of working capital was an important matter, but he thought they would agree that its importance, speaking generally, was more in the early days of the establishment of an undertaking rather than after it had been established for a number of years. He did not know that it was the general practice, but some undertakings, at any rate, had obtained their working capital by collecting as much money as was possible on monthly account, and if they did that, especially in connection with large consumers, they did undoubtedly ease the position. The Paper pointed out how the costs of supply were made up, and how they necessarily were bound to vary according to circumstances, and that was a point he wished to emphasise. First of all, there were certain supplies which would be given in the form of extra high tension, exactly in the same form in which it was generated. Clearly, that involved less losses and less capital, because there were no transformers or converters, and thus the charge made for it must be very much lower than if it were given in the form of converted supply. This was important, having regard to the manner in which extra high tension generation had become standard. Low tension direct current generation was going very rapidly, and in many cases it had already disappeared. Then again, there was quite an appreciable difference between the cost of supplying low tension a.c. and low tension d.c. In the former case there was no rotating plant to provide, and no attendance. With plain a.c. distribution and plain static transformation also there were comparatively light losses and very much less capital involved. Thus, the form in which the supply was given to the consumer necessarily very largely affected the price. All this, of course, was perfectly well known to engineers, but he rather wanted to take the opportunity of rubbing it in a little more to the Chairmen, because the necessity for differentiation in the different forms of supply was sometimes lost sight of. Mr. Charlesworth and some of the speakers had dealt with capital charges and the higher working expenses due to war conditions. He thought it was a matter of some small credit to those engaged in the industry that, in spite of the tremendous increase in charges in other industries and commodities, the charges for electricity supply had not gone up more than 100 per cent., whereas in many others they had gone up by 200 or 300 per cent. At the same time, he wished to sound a slight note of warning, that these high costs were not going to continue. Most of them were satisfied that pre-war costs were not likely to be reached again, and, in fact, he doubted very much whether it would be desirable that prices and wages should come down to the pre-war figures. On the other hand, there could be no possible doubt at all that whereas new stations during the boom time of prices were costing some £25 or £30 per K.W. of plant installed, these prices even to-day were very much lower, and roughly speaking, he should say that they had fallen by some £5 or £6 per K.W., and in future they would come still lower. Thus, the capital charges would slowly come down. Already interest was coming down, by the reduction in the bank rate, which had fallen by 1 or 1½ per cent. within the last three or four months, and on trade stabilising itself again the bank rate would fall still further, with a consequent effect upon the rate of interest on capital. The Paper also dealt with the question of charges to consumers. He was not going to say very much on that point, because most of them were very well acquainted with the subject, and the President himself had raised it in his Address, but he did heartily endorse all that had been said as to charges in the future being based upon some compound form of tariffs, not only in regard to power supplies, but also for domestic users, if they were going to attain that measure of success which they all hoped to attain.

The PRESIDENT said the question arose in his own mind, and, he was sure, in the minds of many others, as to what Mr. Watson included in his £20 per K.W.

Mr. WATSON said that many of them knew that the total cost of erecting recent generating stations, including land, buildings, sidings, water arrangements and plant, had come out to about £27, £28 or £29 per K.W. installed. Appreciable reductions had already taken place in the building trade, which affected the buildings, and there had also been appreciable reductions in the cost of plant, and he was satisfied in his own mind that plant which, 12 or 18 months ago, cost £27 or £28 per K.W., could to-day be put in for £23 or £24 per K.W.; he believed within the next 12 months we should quite comfortably get down to a cost for new power stations of £20 per K.W., and even lower.

Mr. E. E. HOADLEY (Maidstone), speaking with regard to working capital, said he did not agree that most undertakings felt the want of it in early years. In his case he experienced no difficulty with regard to working capital in the first few years, but his Committee had always adopted the policy of supplying energy at the lowest possible price consistent with keeping the undertaking solvent. The result was that during recent years there had been a great impetus in the demand, and the undertaking had changed from quite a small one to one of moderate size. Thus, now was the time when he was feeling very badly indeed the need for working capital. He had discussed this matter with his Finance Committee, and made certain recommendations to them, and it was then taken up very strongly indeed with the Electricity Commissioners. He had had several interviews, and correspondence lasting several months, and had received an official letter from the Commissioners regretting that they had no powers at the present time to help. The Commissioners had told him, however, that if the Corporation had an overdraft from the bank, that was one way of dealing with the matter, and they apparently were prepared to wink at it. Still, in spite of this, it was not a thing which appealed very much to a Finance Committee, especially when the overdraft ran into a matter of £20,000 or £30,000. Mr. Watson had mentioned the question of extra high tension supply, and also the difference in the cost of low tension a.c. and low tension d.c. That was a matter which had affected him considerably during the last three or four years, and, having read in the Technical Press about automatic rotary sub-stations, he set to work in this direction, and was very pleased to be able to tell the meeting that he now had an automatic rotary sub-station running quite satisfactorily. It was controlled from the generating station, and was situated some 2½ miles away. With regard to charges for electrical energy, there were very few engineers who had striven harder than he had for the enforcement of multi-part tariffs, and he had recently had a seven months' fight with the Electricity Commissioners to enable him to raise the charges for one class of consumer, which was about the most unprofitable class that an undertaking was asked to supply. What he wanted to do was to charge business premises on either the maximum demand system or the telephone system, without giving the option of a flat rate, because unless a flat rate of 16d. or 18d. per unit was charged, in these days of early closing and the Summer Time Act, no other price was remunerative to the undertaking for the ordinary shop. He was rebuffed by the Electricity Commissioners on three occasions. He had received official letters, in which the Commissioners stated that they could not give him what he wanted, but he kept at them, and had at last got from the Commissioners—he did not know under what legal powers, because the Commissioners' Legal Department had on several occasions pointed out to him that they had no legal backing for anything of the kind—permission to charge on the maximum demand system at 1s. per unit for the first 91 hours' use of the maximum demand, and 5d. per unit afterwards, without the necessity for charging domestic consumers any higher rate than was the case at present.

Mr. A. H. DYKES (Beckenham) expressed the opinion that the Paper brought before them more than ever the fact that the crux of the whole matter was working capital. He was not sure, however, whether even now the importance of working capital had been emphasised sufficiently, because undertakings that in the past had had sufficient working capital now found themselves in very great straits to provide what was necessary. With the increased cost of materials, wages, etc., it was more than ever important that ample working capital should be available. He was speaking specially for some of the smaller undertakings, which had been much more badly hit by the war than had the larger undertakings with industrial loads. These small undertakings had had to face increases in wages and in the cost of coal long before they had been given permission to raise their prices, with the result that their finances had got into a very straitened condition. Many of his clients had made applications to the authorities for loans for working capital, but in every case they had so far been refused. It was not necessary to impress the importance of this upon the minds of the Commissioners, because he knew it was already in their minds, but the fact was that they had no powers, and it was imperative therefore to impress upon Parliament the necessity for giving the Commissioners the requisite powers. It should be emphasised more than ever, too, that the fixed price per unit must go. That was the root of a very large amount of the trouble from which they were suffering. People had got it into their heads that electricity should be sold at so much per unit, whereas every one of them in the industry knew that that was an utterly fallacious method of selling current, and until they could disabuse the consumers, including the big manufacturers, of the idea that they should always think in terms of units, thev would not make very much progress. It was only by constant reiteration that this would be done. It was not enough that the Commissioners should give them powers slightly to increase their charges. That was all verv well for the large industrial undertakings who were already supplying considerably below their statutory maximum, but in the case of a very large number of small undertakings, especially in the South, it did not pay them to supply some consumers even at 2s. per unit, and the only way in which they could expect to make them profitable consumers was to charge a rental for the facilities offered and then so much for every unit consumed. They had been told that the cure for these unprofitable consumers was to get them to use kettles, irons, radiators and other domestic apparatus. He had in mind undertakings supplying through high tension mains, possibly with house transformers or a transformer supplying a few houses. They had a consumer with something like half a kilowatt demand for lighting, and then they got a request for 12 K.W. of radiators. They put in a larger transformer, but when they looked at the bills they found that these radiators had only been used an hour a day during some two months of the year, at about 1d. or 2d. a unit, or at any rate, at a very low figure. What was the sense of letting them have current at that low rate; it did not even pay the interest and sinking fund charges on the transformer. Diversity factor did not come in when they had a transformer for each house or a transformer for several houses, and unless they got a charge which paid a reasonable interest and provided a sinking fund on the mains and services he did not see how they could make an undertaking of this character pay. Another great difficulty was the finding of the necessary capital for extensions of mains, and anything that could be done to reduce the cost of mains was to be welcomed. The question of finding additional capital for plant was not so difficult as finding the additional capital for mains. He knew a number of undertakings which were besieged with requests for extensions of mains which they knew in a few years would pay, but under present conditions they could not find the necessary capital. These were questions which did not so greatly concern the large industrial undertaking, but they were a pressing problem in a very large number of small undertakings, and the Paper was extremely valuable because it had brought them to the front. The cost of capital and the provision of additional capital was the underlying root difficulty at the present time.

The PRESIDENT, referring to Mr. Hoadley's and Mr. Dykes' remarks, said he presumed he could take it that the feeling of the meeting generally was that the flat rate per unit should cease. There were cases in which a charge, not of 2s., but even of 42s. or 52s. per unit, would not be enough.

Mr. HOADLEY: That is for what I have been asking.

Mr. DYKES: That is my point also, that, although the price per unit is large, the flat rate per unit must go.

The PRESIDENT: I merely wished to emphasise that.

Mr. C. W. CHARLESWORTH, briefly replying to the discussion, said there appeared to be such a measure of agreement with what he had put forward that there was not very much to be said in reply. He would, however, just deal with two points raised, and contribute a written statement for the Annual Proceedings later if it seemed necessary, when he had read through the shorthand notes. Firstly, with regard to the repayment of capital, he did not advocate postponement, but under the present arrangements, where they employed a terminable annuity or sinking fund system of redemption, the annual charges on account of repayment were equal over the entire life of the asset. That condition might with advantage be altered so that the earlier years, when the asset was not so productive, would be relieved of a burden which could be quite easily borne during the later years. There was a further point, and he thought he had made it clear in diagram No. 1. Sinking fund contributions or redemption of capital were only a portion of the total amount they had to meet for capital charges. To take an example, in repaying a loan of £100 over a period of 60 years they had to meet a total expenditure of £390; only £30 of that was claimed by the sinking fund, and £360 was taken in interest. If the interest could be reduced, or some means found of financing the industry so that interest would not have to be paid—(laughter)—it would make a very big difference. The second point was the question of working capital, and Alderman Beaumont had stated that he had not suggested a remedy in the Paper. If they would look, however, at Page 39 they would find that he said:—"It is, therefore, necessary to have power to borrow for this purpose, such power to be exercisable in the absence of a reserve fund sufficient to meet the requirements." He had also, on the same page, advocated issuing monthly accounts for large consumers, a point which Mr. Watson had dealt with, and he personally had found this a great help. He had also shown how a loan for working capital would help the undertaking, and had stated:—"The writer has calculated, from what may be assumed a typical example, that where a bank overdraft has to be obtained, costing £1,300 per annum in interest, the position could be met by a loan costing in all £2,150 per annum; but, in the one case at the end of twenty years conditions would not be improved, while in the other case the loan would be liquidated, and at a gross extra cost of £17,000 the undertaking would have accumulated a desirable reserve fund of £30,000." That was one of the advantages which would be derived from having power to borrow for the purposes of working capital—they would automatically, year by year, create a reserve fund.

The meeting then adjourned.

In a further (written) reply to the discussion Mr. Charlesworth stated :—

It would appear that the instances given by Bailie W. B. Smith in connection with repayment periods prescribed, of twenty-five years for lands and buildings, refer to an equated loan covering several classes of assets having different lives, and if this be so it is very probable that the actual periods granted for these two items were sixty years for the lands and thirty years or forty years for the buildings. Alderman W. Walker properly pointed out that the expenditure on lands and buildings forms but a small percentage of the capital outlay by electricity supply undertakings, and therefore these two items in a loan of any magnitude would have but small weight in the determination of an equated period. However, the correctness of any equated period can easily be checked, having particulars of the various items and the lives allotted to each, by the following method :—

(1) Cost of Item or Group.	(2) Life of Item or Group. Years.	(3) Interest at which Sinking Fund Accumulates	(4) Present Value of Amounts in Col. 1.
£5,000	60	3½%	£635
£10,000	30	3½%	£3,725
£50,000	20	3½%	£25,186
£20,000	15	3½%	£11,400
£15,000	10	3½%	£10,634
£100,000			£51,580

$$\text{Equated period} = \frac{\log 100{,}000 - \log 51{,}580}{\log 1.035} = 19\tfrac{1}{4} \text{ years.}$$

The writer does not agree with equated loans for electricity supply undertakings, for the reasons stated in the second paragraph on Page 38 of his Paper.

The primary object in prescribing a repayment period for loans sanctioned is to ensure that no portion of the debt shall be outstanding when the economic life of the asset covered has expired, so as not to throw the burden of repayment on consumers beyond that period. While it is true that there is a distinct difference between the financial methods of municipal and company undertakings (and naturally so because of the difference in conditions and obligations) both must, if the undertakings are to be kept financially sound, make proper and sufficient provision for depreciation, or difficulties will inevitably follow. Companies have no advantage whatever over municipalities in this respect, as explained in the last paragraph on Page 37 of the Paper, but they do enjoy greater liberty in utilising the moneys reserved. This, however, has been of doubtful good in certain cases where it is known that such liberty has been a little too freely used, with subsequent distress to the shareholders. A strong position is assured by the present regulations relating to municipalities, and it is generally accepted that the repayment periods provisionally decided upon by the Electricity Commissioners for the various classes of assets are eminently reasonable and fair. The writer heartily agrees with Alderman W. Walker's and Alderman J. A. G. Beaumont's remarks on this subject, and considers that the general effect of allowing an indefinite repayment period would be very unfortunate indeed throughout the whole industry.

It has frequently happened in the past—and with progress will probably happen in the future—that the repayment period granted, short though it may have appeared to the undertakers at the time, has been too long to protect them against loss by reason of factors other than depreciation pure and simple, such as obsolescence, etc., and the writer would draw attention to that section of his Paper headed "Depreciation," Pages 37 to 39, dealing with these matters.

Alderman J. A. G. Beaumont correctly named some of the serious difficulties confronting municipalities in regard to working capital, and although undoubtedly an undertaking suffers keenly from lack of this during its earlier years of working, the importance of the question, especially in the absence of a reserve fund, cannot, as suggested by Mr. S. J. Watson, be confined to such period. Mr. E. E. Hoadley evidently experienced more difficulty when his undertaking had expanded, due, no doubt, to the fact that at the commencement of supply operations in Maidstone the amount necessary was small and could be obtained from balances in hand by the Corporation, or a small bank overdraft which raised no question. The problem assumes a different aspect as soon as the output is so large as to involve spending, say, £50,000 or more on wages, materials, etc., in advance of the revenue. War conditions added the further difficulty of increasing the amount required more rapidly than the revenue increased, because of a larger advance in working costs than standing expenses.

There are two ways of meeting the problem, as pointed out on Page 39 of the Paper, e.g., to create a reserve fund sufficiently large, or to borrow (say by means of a bank overdraft). Both of these methods are ultra vires, although both of them are extensively used, and in the absence of any possibility of carrying on otherwise, their employment is naturally overlooked by the Electricity Commissioners. At the same time, the position is weak, as it is wrong to impose conditions that cannot be complied with. The best way is to face the question squarely, and, as suggested by the writer in his Paper, give powers to raise loans for this purpose, such powers to be exercisable in the absence of a reserve fund sufficient to meet the requirements.

The points raised by Alderman J. A. G. Beaumont as to the difficulty encountered by a municipal undertaking in creating an adequate reserve fund are very real, but while political (the word is used in the sense that Alderman Beaumont employed it) considerations are strong, they are not always correct from a financial or technical point of view, and the writer urges serious consideration of the views he put forward in Section 4 of his Paper.

Mr. S. J. Watson emphasised the points made in the Paper with reference to costs of production, and the writer was pleased to note this because, although the factors involved should be familiar to engineers who have made a study of the subject, very few (if any) systems appear to have been instituted definitely to find on a practical basis the costs of supply to each class of consumer year by year. The writer is inclined to think that, although possibly in no other industry have the principles underlying costs of production been more clearly enunciated, the indefiniteness which seems to exist in numbers of cases is due to the absence of sufficient and reliable data. There is need for better treatment of costing, as distinct from mere expense allocation, in electricity supply, and great benefit would be realised from the provision of definite information and figures properly treated and presented, having regard to the technical aspect of the question. Table No. 2 in the Paper shows a method of treatment on the lines of which it is suggested an extension of the Hopkinson analysis should be made.

It is very desirable that Mr. S. J. Watson's optimism with regard to the prices of plant, etc., should be realised. While the writer concurs as to the doubtful good of a pre-war level, in view of our national obligations, a reasonable point is urgently needed if the country is to avoid a disastrous extension of the present stagnation of trade. Fortunately, signs are not wanting that the position is easing, and it is hoped, for the reasons given on Pages 2, 3 and 4 of the Paper, that the electricity supply industry will be able to secure its fair share of any improvements made.

Mr. E. E. Hoadley's success with automatic rotary substations is interesting, as the cost of attendance is large in cases where three shifts are necessary. The problem of direct current supply from alternating current networks is becoming a pressing one in many areas, and it would seem that sooner or later a change over must be made if the greatest economy is to be obtained. The provision of converters and small extensions on the direct current system where immediately unavoidable appears to be only temporising with the position, which for lack of financial abilities it is difficult to tackle in any other way. The writer suggests that the question of loans for the cost of changing over might be seriously considered.

The remarks contributed by Mr. S. J. Watson, Mr. E. E. Hoadley and Mr. A. H. Dykes on the subject of charges for supply clearly indicate how expert opinion has crystallised upon the multipart tariff as the only scientific solution of a problem that has been tackled in many different ways with varying degrees of success. There is a movement afoot to obtain powers to make such a tariff compulsory; while the writer strongly supports this, he would point out the possibility of progress under existing legislation, and the success secured by those undertakings that have been sufficiently enterprising to go as far as they can. It is competent for any undertaking to put a multipart tariff into operation under

Section 31 of the 1899 Act, or its equivalent section in Special Orders, and a great step towards legal sanction to compulsory application would be made by cultivating the ground as much as possible in the meantime and winning public favour to this method of charging. Much more should be done in this direction, especially in view of the vigorous demand for domestic purposes. A multipart tariff offers great advantages to the consumer as well as the undertaker, as is evidenced by its popularity where properly introduced. Wolverhampton may be taken as an example. Here, two scales are offered for lighting and domestic supplies—a multipart tariff or a flat rate, at the option of the consumer, and the result secured has been an overwhelming popularity of the multipart tariff. The great majority of these supplies is taken under this system, and, in fact, during the year 1920-21, the units sold for lighting on the flat rate only amounted to 4 per cent. of the total sales.

The writer urges that the question of tariffs should always be considered closely in connection with sales and commercial development, and the most made of the educational possibilities of a live Sales Department. The case given by Mr. A. H. Dykes is a hard one for the undertaking concerned, but the matter must be dealt with in as broad and enlightened a spirit as possible, having regard to classes of consumers rather than individual cases. The convenience to be secured by consumers from the use of a large range of lightly loaded appliances both for business and domestic use is, in the hands of an able salesman, an effective argument for multipart tariffs. Mr. S. J. Watson was the only speaker to mention the subject of sales and commercial development. In future, with the progress of linking up and the concentration of generation for large districts, the attention of existing undertakers will be directed more and more to this question. The commercial side of the business, which is really only just beginning to receive the recognition it deserves, will prove to be a very important branch, and the altered conditions will demand superior address and business getting capacity than has always been in evidence up to the present. Service in electricity supply cannot nowadays end in the provision of electrical energy at the consumers' terminals; we have developed beyond that, and there is a real need for extended operations if the most is to be made of the growing appreciation by the public of the benefit to be obtained by adopting electrical methods.

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